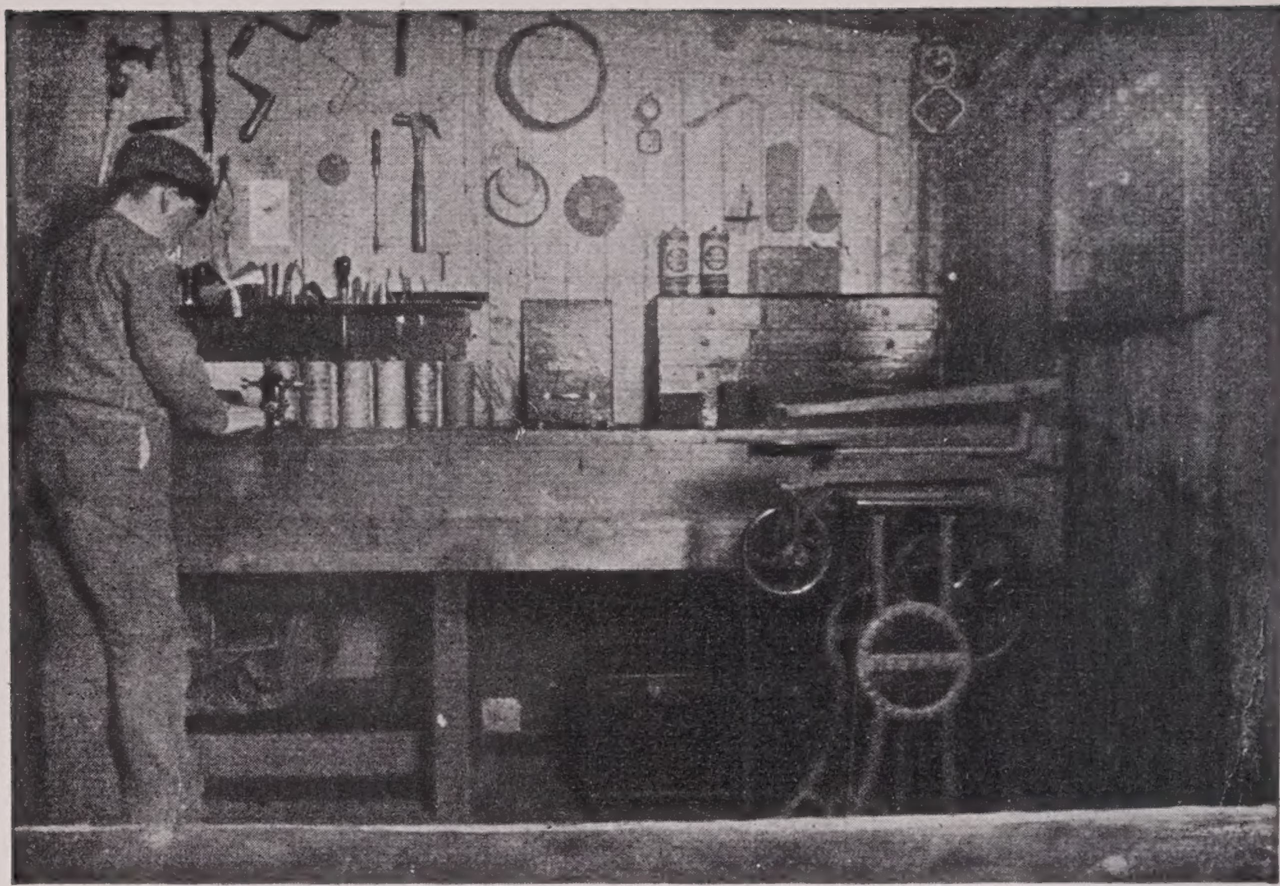


"*Modern Electrics.*"

A Boy Craftsman in His Workshop.

This Indoor Fuselage Model Won First Prize, a Silver Cup, and a Trip to Europe for its Builder, Louis Erhardt.

# HANDICRAFT FOR HANDY BOYS

Practical Plans for Work and Play with Many Ideas for Earning Money

lbert

*By* A. Neely Hall

*Author of "The Boy Craftsman"*
*"Handicraft for Handy Girls"*
*"Home-Made Toys for Girls and Boys"*
*"Home-Made Games and Game Equipment"*
*"The Handy Boy"*
*"Carpentry and Mechanics for Boys"*
*"Outdoor Boy Craftsmen"*
*"Big Book of Boys' Hobbies", Etc.*

With seven hundred illustrations and working drawings by the author

*New and Enlarged Edition*

BOSTON
LOTHROP, LEE & SHEPARD CO.

Handicraft for Handy Boys.

*REVISED EDITION*

Printed in U. S. A.

**When you *play,* play *hard;* and**
**when you *work,* do *not* play at all.**
**— Theodore Roosevelt.**

# INTRODUCTORY NOTES

This is a companion volume to "The Boy Craftsman," and is intended for the same class of readers, — boys who want *the latest ideas for making things*, *practical plans for earning money*, *up-to-date suggestions for games and sports*, and *novelties for home and school entertainments*.

There are all sorts of Handicraft for Handy Boys in this new volume. Some of the ideas will appeal more directly to younger readers, while other ideas will be better suited to the older lads who have become more capable through experience with earlier ventures and advancement in school. At the time of the publication of "The Boy Craftsman," the author advanced the opinion that it is well to provide a boy with a book which contains not only a goodly measure of the simple work requiring little or no experience in the handling of tools, but also the proper instruction to help him grow more proficient, and such advanced work as he will then be prepared to undertake; and the success of this former volume has proven that such a book gets right next to a boy's heart, that it furnishes him with ideas for many years' work, and that it produces the best possible influence over him in encouraging him to be industrious. Every young fellow loves to plan and dream about what he is "going to do" some day, and in simply looking over the more advanced ideas in a book of this kind, he experiences, in his imaginative mind, much of the pleasures that his older brother or friend gets out of the actual work; for this reason, no school boy is too young to enjoy such a book, and the act of placing a copy

in his hands at an early age will be the means of instilling in him an ambition to make the best possible use of his time, before he has had a chance to acquire a tendency to be an idler.

As in "The Boy Craftsman," *the author has planned the suggestions on an economical basis*, providing for the use of the materials which a boy ordinarily has at hand, — old boards, grocery boxes, cigar boxes, barrels, tin cans, worn-out pans and tins, pails, broom-handles, spools, discarded clocks, broken chairs and other furniture, old hats and clothing, stovepipe, clothes-line, screen wire, and other things too numerous to mention, — besides many things which can be purchased for a few cents. The greater part of the ideas require very little if any outlay of money, and many *suggestions for earning money* have been included to make it possible for a boy to provide himself with all the tools which he requires or wishes to own, without having to call upon the home treasurer for the means for such purchases. These features were brought together for the first time in "The Boy Craftsman," and have won the confidence of parents who realize that, in giving a book of this kind to their boys, they are providing something which will encourage self-reliance and resourcefulness rather than a dependence upon home for money for tools and working material — which is often the cause of endless worry where such cannot be furnished. The work is along such lines as will interest the boy with unlimited funds at his disposal, as well as the boy in moderate circumstances, and, inasmuch as it has been planned on a small cost basis, it should be the means of doing him more good, and help him to form a firmer foundation for later years, than something which might tend to cultivate a love for extravagance.

*Much of the work is closely allied to the studies of the modern grammar and high schools*, as will be seen by glancing over the table of Contents, and it is hoped and believed that

this outside instruction will be the means of helping boys to appreciate the value of close application to studies.

It is impossible to make a book of this character complete, in the sense of covering every scope of work and play in which boys are interested; for the field is practically inexhaustible, and is growing larger day by day. Every new development in the scientific world is being investigated by an eager army of boys possessing an unquenchable thirst for something new, and generally some young mechanical genius discovers how to introduce the idea into the boys' realm of work; and if costly apparatus was used in the original experiments, he "plugs away" until he finds out how this can be made, wholly or partly, with the materials boys are accustomed to work with,—the truck to be found about the house, in the shed, in alleys and in junk shops, and inexpensive stuff. This sort of original investigation should be encouraged in boys, and no better way can be found than by providing them with a book of modern and ingenious work which will appeal to their mechanical natures.

Here is an example of the pace at which boys' achievements are following the developments of the day. Every up-to-date boy is now experimenting in electrical work and wireless telegraphy, work which has put into the background experimental chemistry—not long ago one of the principal scientific pastimes, and one of the features of boys' handy books; and he is producing original forms of model aëroplanes, while aëronautics now occupies more of his attention than kite-flying, a fact which no one, a few years ago, would have believed to be possible. With the shifting of boys' interests in work and play, it is only natural for the book which contains the greatest variety of modern ideas to win the greatest amount of popularity. Whether or not this book will meet the present demands of boys, the author is willing to let his readers decide.

The manual training in the first portion of the book has been

provided for the benefit of the boys who have not the advantages of such instruction at school, as well as to help those who have these advantages, in providing themselves with equipment for home use. The chapter on working-drawings has been inserted to instruct boys in enough of the principles of mechanical drawing to enable them to design and work out their own ideas accurately on paper, and the numerous plans for easily made furniture, for cigar-box toys and gifts, clockwork toys, and contrivances for the house and garden, will furnish them with a good supply of ideas to make selections from for shop work. The suggestions for fitting up a boy's room and for making box furniture and gymnasium apparatus will enable boys to provide themselves with rooms furnished to suit their convenience. The chapter on telegraph and crystal radio sets contains practical ideas for home-made apparatus in its simplest forms, the chapter on model airplanes shows some of the best model flying machines, and the "auto-airship" described is a practical scheme for a boy's airship that runs along a rope.

All of the material in this volume has been thoroughly tested, and hundreds of thousands of boys have already had an opportunity to carry out some of the ideas which have been included in the author's articles for boys published recently in *The Ladies' Home Journal* and *Good Housekeeping*, in his "Boy Carpenter" department of *The Boys' Magazine*, and in *The American Boy*. The author wishes to extend his thanks to the editors and publishers of the above publications, for their care in preserving and returning the original drawings for the illustrations to these articles that they might be used in this book.

The author invites correspondence, and is always glad to hear how his boys succeed with their work, and pleased to receive photographs of their handicraft for his collection.

A. N. H.

CHICAGO, ILLINOIS,
May 31, 1911.

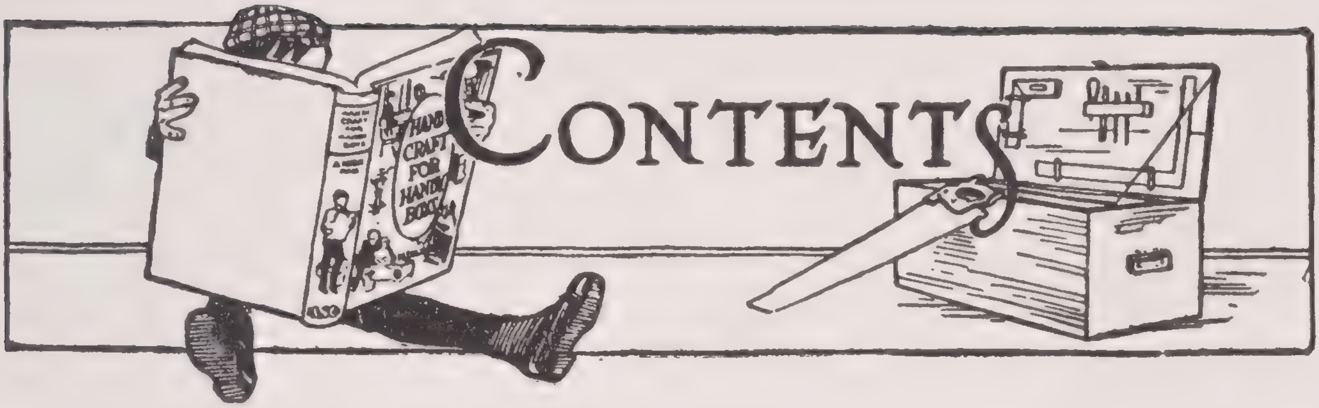
## NOTES TO NEW AND ENLARGED EDITION

**Handicraft for Handy Boys** has come of age. With the rounding out of twenty-one years of service to boys, this new and enlarged edition has been prepared. This was the first book of hobbies with plans for model airplanes, wireless telegraphy, scout craft, bird-house building, home manual-training, and mechanical toys, and these hobbies are now brought up to date with new plans, new materials, and new assembly methods.

In preparing this edition, the author has been guided by suggestions from his readers. Many of these readers, grown to manhood, keep in contact with the author by letters and by visits to his studio, and their interest bears testimony to the book's lasting influence on projects of the type presented.

A. NEELY HALL.

ELMHURST, ILLINOIS,
March 25, 1933




# PART I

## *AUTUMN AND WINTER HANDICRAFT*

### CHAPTER I



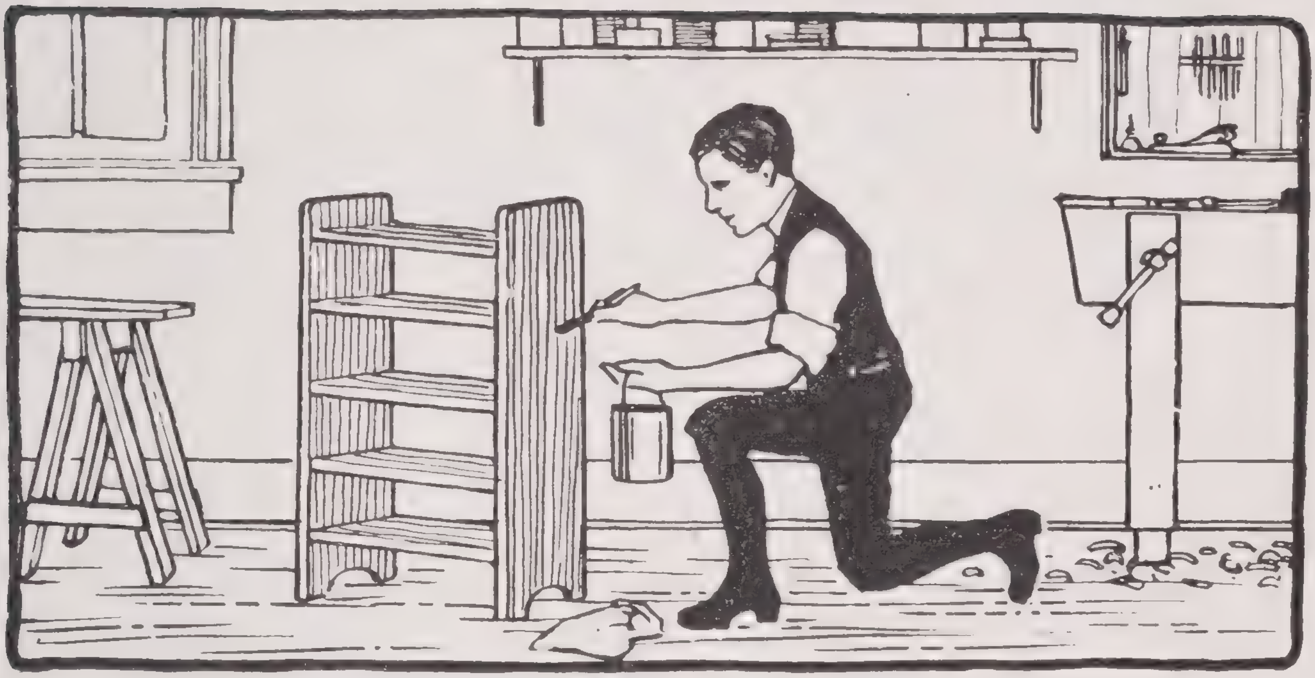
### CHAPTER II

# LIST OF HALF-TONE ILLUSTRATIONS

(In addition to more than five hundred text illustrations.)

## PART I

## PART II



# PART I

# Autumn and Winter Handicraft

# CHAPTER I

## THE HOME WORKSHOP

With the coming of autumn and the beginning of the new school year, the majority of you boys who have enjoyed all summer the freedom of outdoor life probably pick up your books with a feeling of regret that you must knuckle down again to studies. But as soon as you meet all the boys and get to talking over last year's good times, your old school enthusiasm returns; then when some one proposes something interesting to do, you at once fall into line with the other fellows in offering suggestions, and the chances are that before the day is over you are ready to admit that school life is pretty good after all. In the course of a day or so football is under way, and possibly plans have developed for an athletic club and literary society, while all sorts of schemes have been undertaken by groups of boys who have found that they can work together congenially, and very likely each boy has mapped out a lot of individual work to do. These outside interests help probably more than anything else to keep school from becoming monotonous.

To be able to fix up a club-room or make furniture for your own room, construct apparatus for a "gym" and prepare the various "properties" for school or neighborhood "shows"; to be able to build wagons, boats, sleds, kites, model airplanes, and other things just a little better than those the other fellows have made; to be able to make pieces of handicraft which will be presentable as Christmas and birthday gifts to your friends and relatives; in short, to be handy about doing things in general is an accomplishment which every one of you boys should strive to attain; but before you can expect to do all of these things well it will be necessary for you to know not only how to use carpenters' tools properly, but also how to go about the work in the right way. This is the author's reason for beginning this book of handicraft for you with instructions upon manual training.

Unless you have a workshop, or at least a space large enough in which to set up a work bench, you will be handicapped for any kind of home carpentry, for to get good results it is necessary to have something strong and solid to work upon and a vise which will hold your pieces of work firmly. The basement, attic, a spare room, the woodshed, and garage suggest possibilities for fitting up a good workshop, but in

**Selecting a Suitable Place** there are several important things to consider. The shop should have good light, it should be dry, to prevent your stock from getting wet

and your tools from rusting, and it should be located conveniently, so that material can easily be carried in and out, and far enough away from the living-room and bedrooms so that your hammering will not disturb any one. Of course, some of you will have no choice in the matter and will have to take any place you can get, but in this case make the best of the conditions for the time being and perhaps something better will turn up later on. If you locate your shop in the basement or attic, it will be a good idea to partition off a space as large as you will need and provide a door with a padlock which can be locked to keep things from being tampered with by younger hands. The building of a partition is described on page 149 and illustrated by Figs. 172 to 175. If there are no

**Electric Light Outlets** install one or two over the position for your work-bench, and a two-plug or three-plug receptacle in a convenient location for motors. Some day you may have the good fortune to own an electric jig-saw, lathe, circular-saw, and other motorized machines. The best installation is wire in conduit, or armoured cable, extended from a separate circuit in the service box.

**Cabinet-made Benches** can be bought at any of the large stores where tools are sold, for from $7.50 to $50, but one of these will serve your purposes no better than the old-fashioned

**Home-made Bench** to be found in almost every carpenter shop. One of these can be made by any boy, out of

pine, cypress, or whitewood. The well-made cabinet benches have maple tops, but it is not necessary to go to the expense of buying maple for your bench, as softer material will do just as well. Dressed 1-inch, $1\frac{1}{4}$-inch, or 2-inch stock may be used for the top, 2-by-4-inch stuff for the framework, and 1-inch boards for the aprons and rails; 4-by-4-inch stock is often used for bench legs, but "2-by-4's" are plenty heavy enough and generally easier to get.

Figure 1 shows

**A Solid Work Bench**, 2 feet 8 inches high, with a top 5 feet long and 24 inches wide. This is a good size to make your bench if you are crowded for room. If you would like to have it longer, it is a simple matter to add whatever you wish to the lengths given for the different pieces, and if you find that it is going to be too high for you, it is easy enough to saw off the legs before making the vise. Figure 2 shows the framework with the different members lettered. Cut the four legs *A* 2 feet 8 inches long, less the thickness of the crosspieces *B* ($1\frac{3}{4}$ inches) and the top, the 2-by-4-inch crosspieces *B* 22-inches long, the end rails *C* 22 inches long by $3\frac{3}{4}$ inches wide, and the front and back rails *D* 4 feet long by $3\frac{3}{4}$ inches wide. Spike crosspieces *B* to the tops of the legs, and rails *C* to the sides 8 inches from the lower ends; then stand the frames thus formed on end and connect them by means of rails *D*. Cut a front and a rear *apron* (*E*, Fig. 2) 5 feet long, out of 10-inch

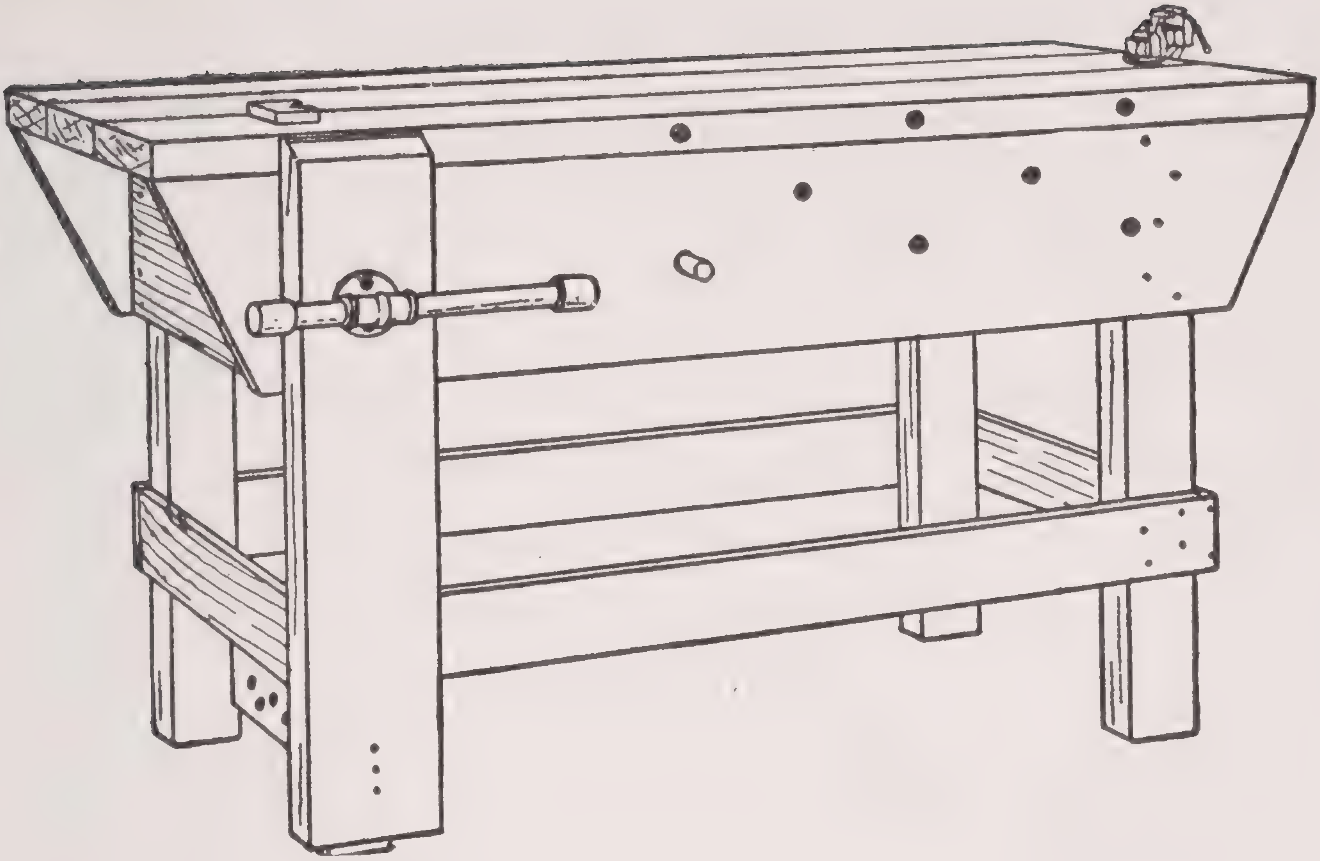


FIG. 1. — A Solid Work Bench.

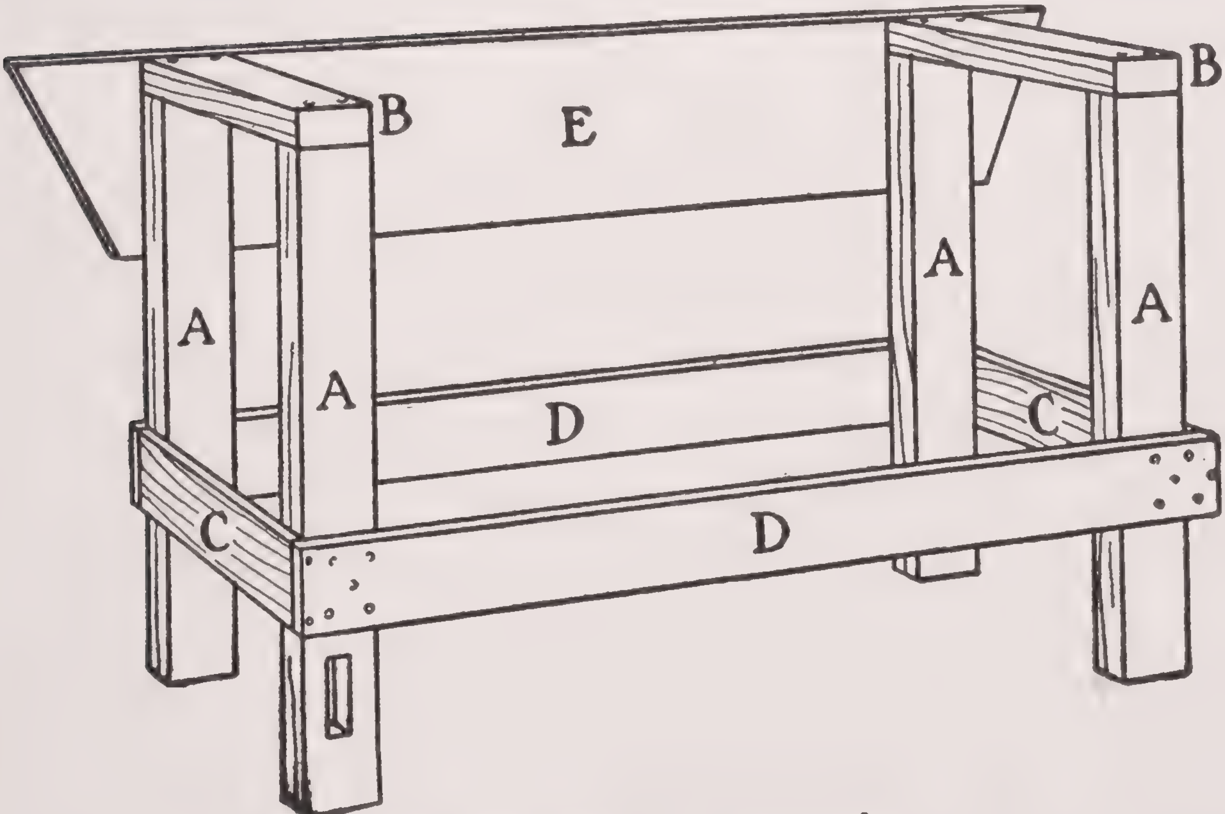



FIG. 2. — Detail of Framework.

boards, saw off the ends on the diagonal as shown, and then either nail or screw them to the bench legs, placing them with their top edges even with the top of cross-pieces *B* and with their ends projecting the same distance beyond the ends of the bench framework. The bench top may be made of three pieces 8 inches wide, or of any combination of widths that will make up a total of 24 inches, and these pieces should be fastened to cross-pieces *B* with screws. *Countersink* the screw-heads. Finish the ends of the bench by fitting pieces of 10-inch board between the aprons, as shown in Fig. 1.

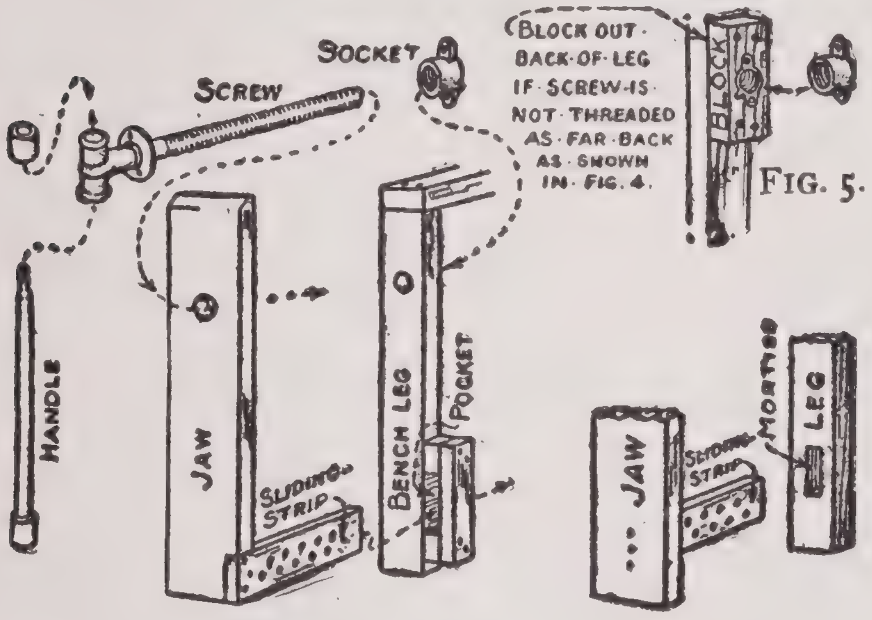



FIG. 5. FIG. 4. FIG. 3.

FIGS. 3–5.—Details of the Bench-vise.

Figures 3, 4, and 5 show the details for making

**The Bench-vise.** Cut the *jaw* about 31 inches long out of a piece of $1\frac{1}{2}$-inch or 2-inch stuff 6 inches wide, and the *sliding strip* 3 inches wide and 14 inches long out of a 1-inch board, and bore ten $\frac{1}{2}$-inch holes through the sliding strip about $\frac{3}{4}$ inch on centers and *staggered* as shown. There are several ways of fastening the sliding strip to the jaw, two of which are shown in Figs. 3 and 4.

By nailing the jaw to the end of the strip, as in Fig. 3, it is necessary to mortise the bench leg for it to slide through, while if you set the strip into the side of the jaw, as in Fig. 4, a pocket must be built on to the side of the leg. If you mortise the leg, make the mortise about $\frac{1}{4}$ inch larger all around than the strip, so there will be plenty of clearance, and locate the bottom of it 3 or 4 inches above the floor. After fastening the sliding strip to the jaw, slip the end through the mortise — or through the pocket, push the jaw up against the apron of the bench, and drive a couple of nails through it to hold it temporarily in place.

**An Iron Bench-screw**, socket and wooden handle (Fig. 4), can be bought at almost any hardware store for 50 cents. If this screw is $1\frac{1}{4}$ inches in diameter, describe a circle $1\frac{1}{2}$ inches in diameter on the face of the jaw, 8 inches below the bench top, and then bore a hole of the same diameter through the jaw, the apron, and the bench-leg (see "Cutting Large Holes," page 142). With a chisel enlarge the hole on the inside face of the leg (you had better turn the bench over upon its side to do this) so the iron socket will set into the leg flush with the surface; then, after screwing the socket to the leg, trim the hole in the jaw so the *collar* on the handle end of the screw will set flat against the jaw, and screw the plate in place. Some of the bench-screws are made to go through heavier stuff than we have used for the legs, and their threads stop within 3 or 4 inches of the collar plate; in

this case it becomes necessary to set the socket into an extra block of wood (Fig. 5) and to spike this block to the back of the leg; otherwise, the jaw would not close entirely. Trim off the top of the jaw even with the bench top and bevel the outer edge (Figs. 1 and 4), then remove the temporary nails. Cut a peg to fit in the holes in the sliding strip, and whenever you use the vise, stick this peg into the proper hole to keep the bottom of the jaw from pushing in farther than the upper portion; the jaw must be kept vertical in order to make it grip a piece of wood squarely.

Bore several rows of $\frac{3}{4}$-inch holes through the front apron, as shown in Fig. 1, and cut a peg to fit in them. This peg may be adjusted to support the end of any length of board placed in the vise.

Never clamp screws, nails, or other pieces of metal in your vise without placing them first between blocks of wood, as they will cut up the face of the jaw and bench apron and soon make the vise unfit to hold your nice work. It is a good plan to have

**An Iron Vise** for metal work; one of these can be purchased for from 50 cents to $1 and may be screwed to the right end of your bench (Figs. 1 and 6).

Figure 6 shows

**A Work Bench with Tool Drawers**, which is almost as simple to make as the one just described. The drawers are grocery boxes and slide into the ends of the bench on the upper rails of the framework (Fig. 7). The bench

A Basement Workshop.

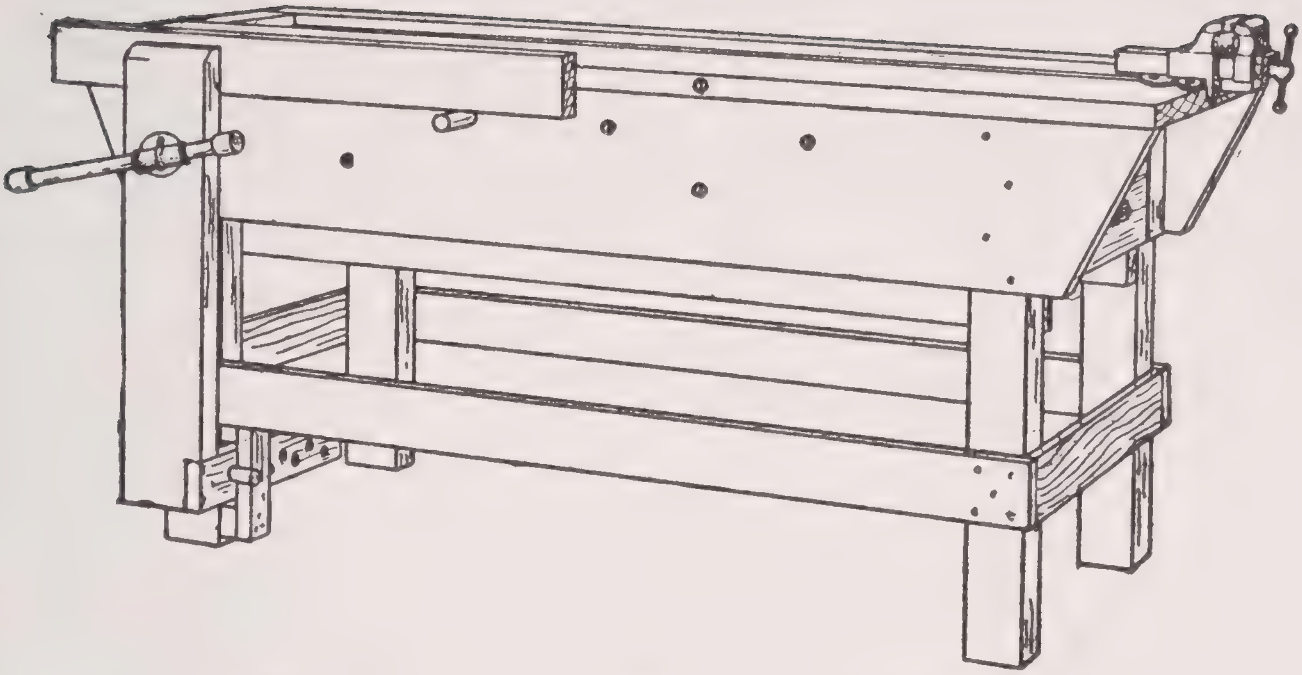


FIG. 6. — A Work Bench with Tool Drawers.

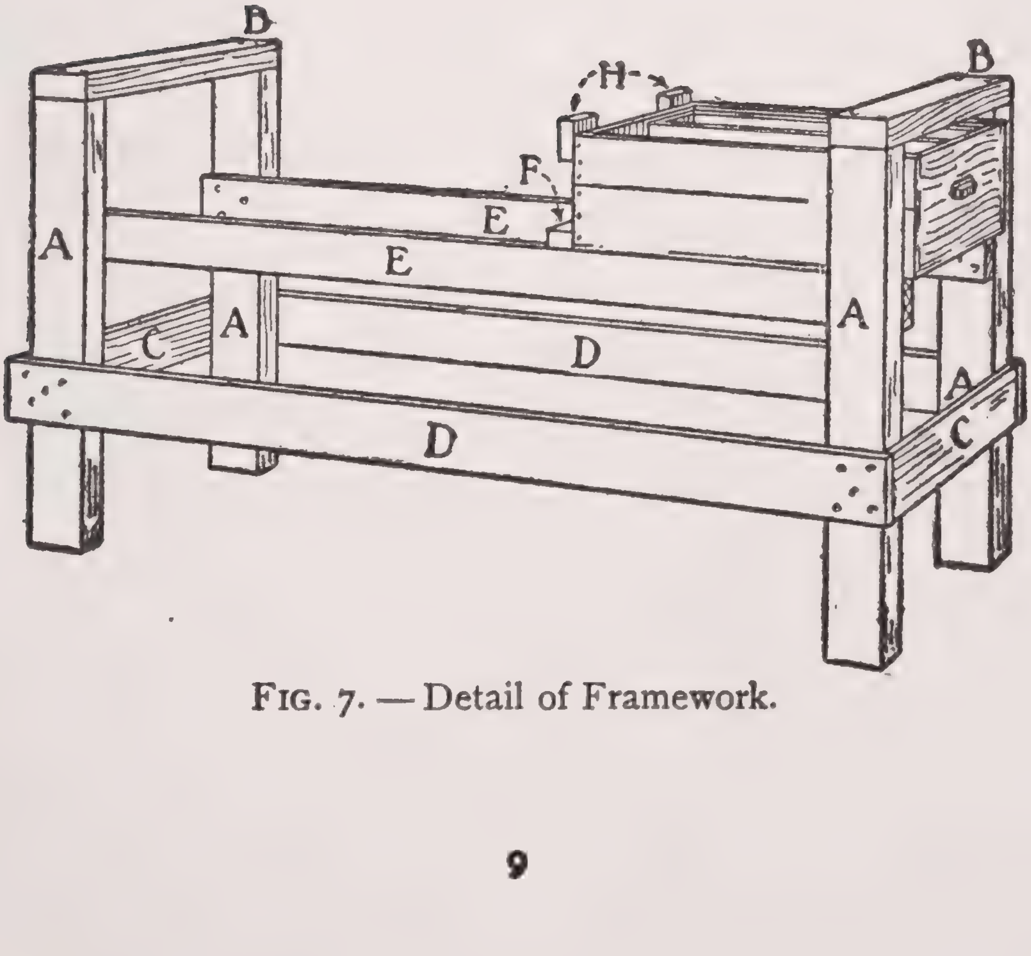



FIG. 7. — Detail of Framework.

illustrated is 6 feet long, 24 inches wide, and 2 feet 8 inches high, but as mentioned before you may change these dimensions to suit your conditions, and if you prefer to make a cabinet for your tools instead of keeping them in the bench, the drawers may be used to hold supplies. Figure 7 shows the framework of the bench. Make the end frames as described for the other bench, fasten them 4 feet 2 inches apart with the front and back rails *D*, and then cut the upper rails *E* which form the drawer slides and nail them to the legs 8 inches below crosspieces *B*. If you cannot find boxes of the proper size for

**The Tool Drawers**, larger boxes may be cut down, or you can build up drawers to fit. Provide the drawers with removable trays, such as are described for the tool-chest shown in Fig. 43, page 31. Nail two guide strips (*G*, Fig. 8) to the bottom of the drawers and fasten an iron drawer-pull or a wooden handle to the front. Then nail two striking blocks to the back (*H*, Fig. 7) to prevent the drawers from pulling out of the bench, and two crosspieces (*F*) in the proper places to stop the drawers when they have been pushed in flush with the ends of the bench. Figure 6 shows

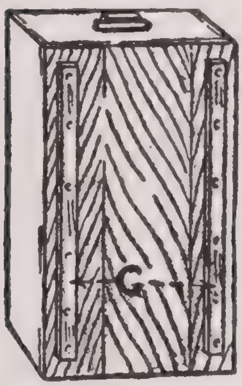


FIG. 8. — Box Tool Drawer.

**A Tool Tray** *recessed* in the bench top — a good arrangement, as it provides a place to lay tools while working. This top may be made by placing a 12-inch plank along

the front of the top, an 8-inch board back of it, and a piece of 2-by-4 back of that again (Fig. 9), and then blocking out the ends of the board flush with the top of the planking. To finish off the ends of the bench, fit in strips around the drawers.

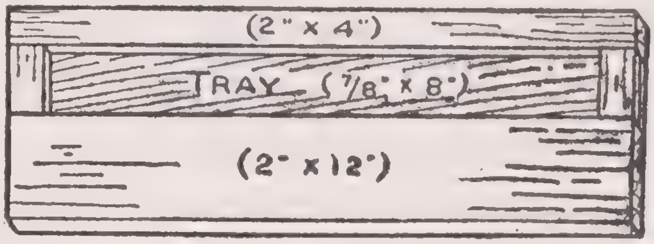



FIG. 9. — Plan for a Bench Top with Tool Tray.

Before adjustable *bench-stops* were put upon the market, a carpenter had to devise various makeshifts for shoving work against for planing and for other operations, and as many of these are still in use, I am going to show you a few of the good forms of

**Home-made Bench-stops**, so in case it is not convenient to buy an iron stop, you can equip your bench with one

FIG. 11 FIG. 12.

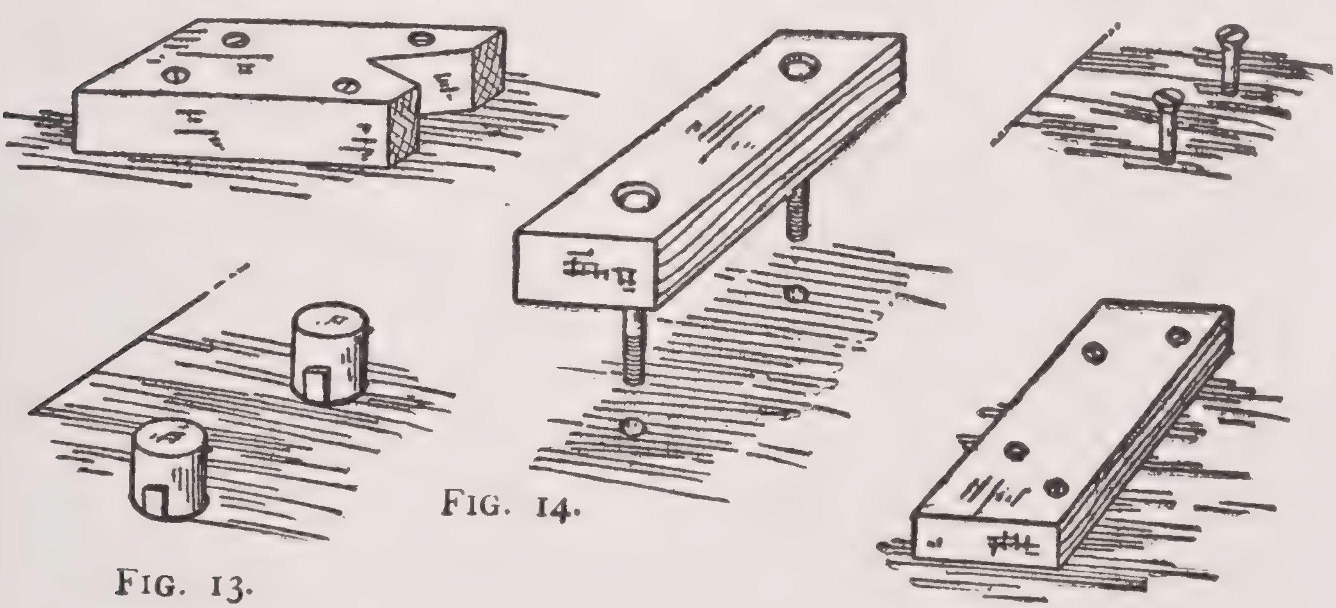


FIG. 14. FIG. 13. FIG. 10.

FIGS. 10–14. — Home-made Bench-stops.

of these. The stop shown in Fig. 10 consists of a short strip of wood, which is screwed in place to the bench

top, and the screw-heads are *countersunk* as a protection for your edge tools. By screwing the strip in place, it is easily removed when you wish to have the bench top clear. Figure 11 shows a block with a "V" notch cut in it. This will hold the ends of narrow pieces of work. Screw stops (Fig. 12) are a favorite form, as they are easily adjusted to a required height by giving them a few turns with a screw-driver. The peg stops shown in Fig. 13 have a big advantage in the fact that they are quickly removed. Bore two $\frac{3}{4}$-inch holes through the bench, cut the pegs to fit loosely in them so they may be adjusted to the proper heights for different pieces of work, and drive in a *hammer wedge*, or a wooden wedge, at the side of the pegs to hold them in position. The stop shown in Fig. 14 is similar to that shown in Fig. 10, except that it is held in place with bolts instead of screws. Get two $\frac{3}{8}$-inch carriage-bolts about 4 inches long, and cut several strips of wood about 8 inches long and of different thicknesses. Bore two $\frac{3}{8}$-inch holes, 5 inches apart, through the bench top and through the strips for the bolts to drop through, and countersink for the bolt-heads. This stop is handy, as the strips may be interchanged to suit work of different thicknesses. Figure 15 shows

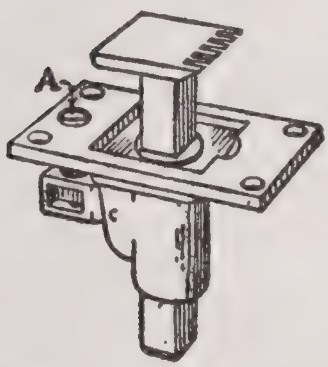
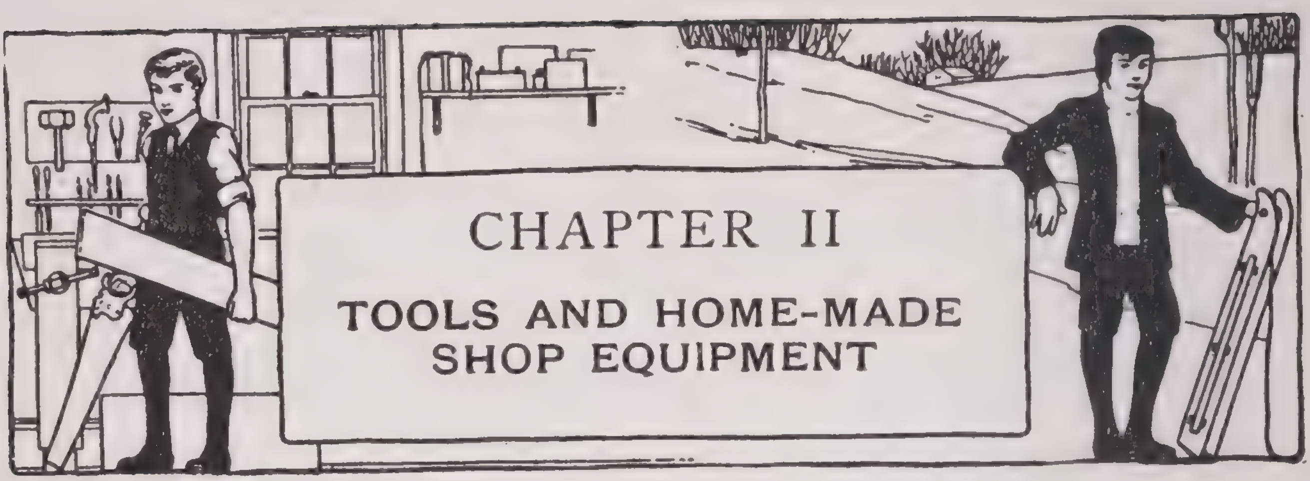


FIG. 15.—An Adjustable Bench-stop.

**An Adjustable Bench-stop** which retails for 50 cents. The *pin* in the center of this stop is released by giving the

screw marked *A* a few turns with a screw-driver, and may be set to the proper height for your work and dropped flush with the plate when not in use. Mortise the bench top for the stop, and set the plate flush with the top.

The other shop equipment is described in the following chapter.



# CHAPTER II

## TOOLS AND HOME-MADE SHOP EQUIPMENT

Better results may be obtained with a few tools of the best quality than with an entire outfit of cheaper grade. Remember that, boys, when

**Purchasing Tools**, and be sure that you get those made by reliable manufacturers instead of the toy variety, for though they will cost considerably more, their better wearing qualities will make them cheaper in the long run. You will find new-fangled tools for every conceivable form of work in the modern carpenter shop, but do not imagine for a minute that it is necessary to have these in order to perform the operations for which they are especially made. A good mechanic can complete almost any kind of a job with a handful of tools, but special tools do the work so very much quicker that they are adopted as time-saving devices, and usually are worth many times their cost in a large shop.

Unless you have received instruction in manual training, the variety of styles and sizes in which tools are made may make the selection of an outfit difficult; so to provide

**A Handy Guide for Purchasing**, the more desirable forms and sizes of all the tools which an amateur is ever likely to require have been described and illustrated upon the following pages.

A hatchet, hammer, saw, plane, chisel, jack-knife, bit and brace, screw-driver and square are mentioned in "The Boy Craftsman" as

**The Principal Tools** which a boy requires. If you cannot afford more at the start, add to them as soon as you can. Figure 16 shows illustrations of

**A Small Outfit** which a boy will find sufficient for any kind of ordinary carpentry. Every tool in this outfit is an important tool and one which you will find necessary for general use. As your money permits, you will wish to add to these tools several sizes of chisels and bits, one or two saws, and such other tools as are used in advanced work, and in this way you can increase your outfit, until before long you will have a fairly complete set of tools of which you may be proud.

First of all, you will need a good

**Jack-knife.** By this is not meant a four-blade pocket-knife with a polished pearl handle, but just a common knife, strongly made, and having blades of steel properly tempered so they will hold an edge. A two-blade knife with wooden handle similar to that shown in Fig. 16 is a desirable form for all-round work, and is made in a medium-priced knife with blades of a good quality of steel.

For general use

**A Hatchet** with a claw (Fig. 16) is to be preferred to one without, as it may be used for withdrawing nails as

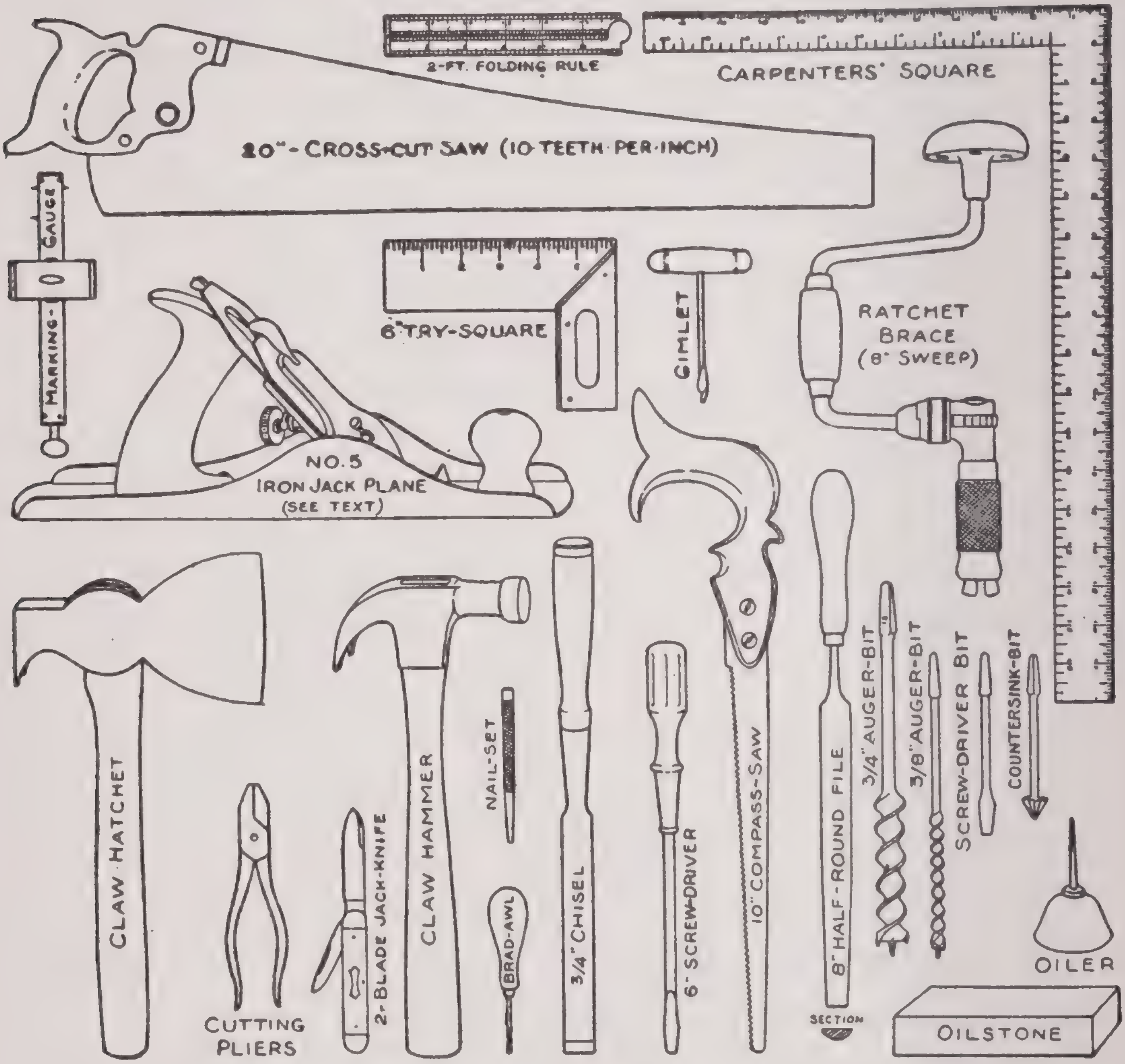



FIG. 16. — A Small Tool Outfit.

The most important tools, showing desirable forms and sizes. Additional tools may be selected from those shown and described upon the following pages, as your money permits and your work requires their use.

well as driving them. In buying a hatchet, select one of medium weight and see that it balances nicely when

you swing it, for, if unevenly balanced, it is cumbersome to handle and tires out the hand and arm muscles needlessly. This is a point also to be looked out for in buying

**A Hammer.** Get a medium-sized claw hammer, either with a *bell* face (Fig. 16) or a *plain* face,—it does not matter which,—and if possible get one with the head fastened on with *patent-lock* wedges which make it impossible for it to loosen and fly off.

An ordinary

**Tack Hammer** is handy for working in small corners, but can easily be dispensed with for ordinary work. A much more useful hammer is the

**Crate Opener** shown in Fig. 17, which is handy not only for prying boxes apart, but also for driving and withdrawing tacks and small nails. It may be used for numerous small jobs, and its convenient size makes it possible to carry it about in one's hip pocket.

FIG. 17.

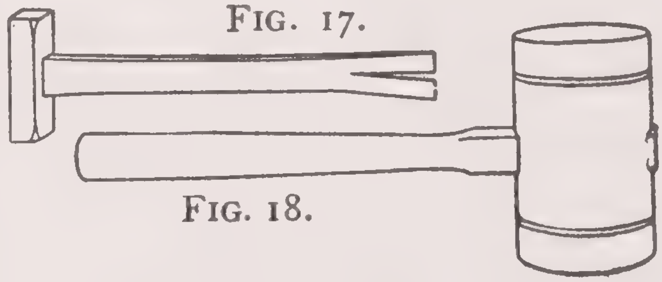


FIG. 18.

FIG. 17.—Crate Opener.
FIG. 18.—Wooden Mallet.

**A Nail-set** is required for driving nail-heads below the surface of work before finishing it. A *cut* iron nail may be used, but it is not as satisfactory as the regular nail-set shown in Fig. 16. You will find it handy to have two sizes, one for *finishing-nails*, the other for *common nails.*

It is advisable to have

**A Wooden Mallet** (Fig. 18) for mortising and cutting

where it is necessary to drive the chisel or gouge, as the use of a hammer soon splits down the end of the handle. This is also useful for knocking together the members of *halved*, *mortise-and-tenon*, and other joints.

**The Cross-cut Saw** (Fig. 16) is made to cut across the grain of wood. It will also cut with the grain, but as the teeth[1] are not properly prepared for *ripping*, the work is slower to do. When money permits, you should add a 22-inch

**Rip-saw** to your outfit. The

**Compass-saw** (Fig. 16) is made especially for cutting curves, the teeth being filed to cut with as well as across the grain, and it is handy for sawing thin wood. A finer saw which you may prefer to the compass-saw is the

**Keyhole-saw**, made for cutting keyholes as the name would imply, and used for various other small jobs. This is often made to fit in a handle similar to that of the compass-saw, but the more common form is the one which fits in a *pad*, as shown in Fig. 19. Other forms of saws which you will want to add to your outfit as soon as possible are the

**Back-saw**, shown in Fig. 59, a saw made with fine teeth (get one with fourteen teeth to the inch) and intended for very fine cutting — such as for making miter-joints, cutting tenons, etc., and either a

**Coping-saw** or **Bracket-saw** (Figs. 20 and 21) for saw-

[1] See notes regarding the teeth of the *Cross-cut Saw* and the *Rip-saw* on page 21 of "The Boy Craftsman."

ing thin wood.

**A Scroll-saw or Jig-saw,** with motor, will facilitate the cutting of curved pieces.

**A Hack-saw** will be needed for metal work.

**A Jack-plane** (Fig. 16) fitted with a *smoothing-plane iron* is to be preferred to a smoothing-plane, if one plane must be chosen, for its long *sole* (bottom face) makes it easier to plane up a surface without hollowing it. This plane, thus equipped, may be used for both reducing thicknesses of material and removing *undressed* surfaces (the purpose of the jack-plane), as well as planing up surfaces true and smooth (the purpose of the smoothing-plane). The jack-plane iron has its cutting edge slightly rounded, instead of being ground straight across like the smoothing-plane iron, in order to make it gouge out the wood and thus reduce thicknesses quickly, so you will readily see that it cannot be expected to straighten up a surface. Of course you can buy the two irons and make the plane the equivalent of a jack- and a smoothing-plane. The Stanley "Bailey" adjustable iron plane shown in the illustration is a better form to purchase than the old-fashioned plane with a wooden stock, as it is so easily adjusted. The No. 5 size (Fig. 16) is 14 inches long

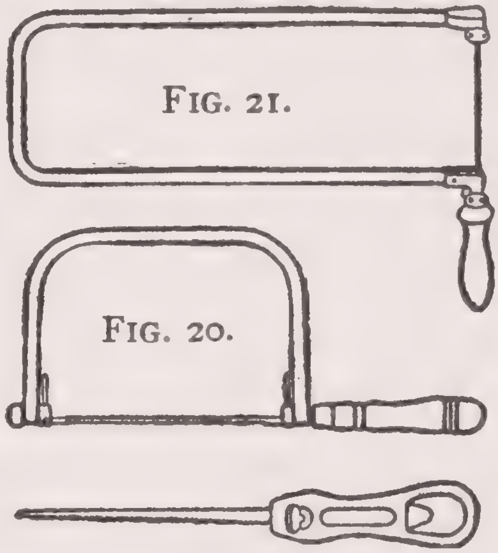


FIG. 19.

FIG. 19. — Keyhole-saw.
FIG. 20. — Coping-saw.
FIG. 21. — Bracket-saw.

and about the right length. As soon as you can do so, buy a

**Smoothing-plane** in addition to the jack-plane, for the two planes will save you a considerable amount of adjustment of the cutting irons. The

**Fore-plane** has an 18-inch sole, and is made long for the purpose of removing the high places left by the jack-plane and straightening the surface before smoothing up with the smoothing-plane, but it may easily be dispensed with by the amateur. Among the many other forms of planes upon the market, you will find a

**Rabbet-plane** (Fig. 22), useful in cabinet making for *rabbeting* your work (Fig. 75, page 59 — the plane-iron, or *cutter*, can be adjusted to any desired width of *rabbet* up to $1\frac{1}{2}$ inches), and the

FIG. 22. — Rabbet-plane.

**Dado-plane** (Fig. 23), which is made for *grooving* (Fig. 75, page 59). As the plane-stock of the dado-plane must be of the same size as the cutter, it is necessary to select one having the width of cutter for which you will have the greatest need, for you will not likely wish to purchase more than one dado-plane. Of course, if you live near a mill, you can get all of your rabbeting and grooving done there, and it will hardly pay you to bother with it, or to purchase these tools.

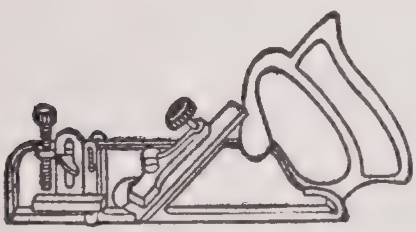


FIG. 23. — Dado-plane.

It is a good plan to invest in a

**Ratchet-brace** when buying a bit-stock, as it can be used in so many places where an ordinary brace cannot. The ratchet arrangement makes it possible to so set the brace that, when boring a hole or driving a screw in a corner or close to something which prevents a full sweep, the handle may be worked back and forth. Buy a brace with at least an 8-inch sweep; a shorter sweep than this does not give sufficient leverage.

A $\frac{3}{8}$-inch and a $\frac{3}{4}$-inch auger-bit are included among the tools shown in Fig. 16. Of course, it is often necessary to bore holes of other sizes, and

**Auger-bits** $\frac{1}{4}$ inch, $\frac{1}{2}$ inch, $\frac{5}{8}$ inch, and 1 inch in size should be added to these as you find need of them. Bits are made in $\frac{1}{16}$-inch sizes, and the number of sixteenths is stamped upon the shank. Figure 24 shows an

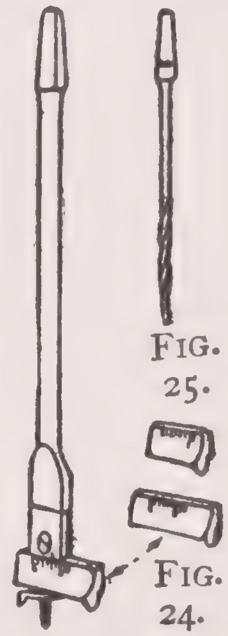



FIG. 24. — Expansive-bit.
FIG. 25. — Wood Drill Bit.

**Expansive-bit**, the small size of which is provided with two cutters — one adjustable to bore holes ranging from $\frac{1}{2}$ inch to $\frac{7}{8}$ inch and the other from $\frac{7}{8}$ inch to $1\frac{1}{2}$ inches; and the large size with two cutters — one boring holes from $\frac{7}{8}$ inch to $1\frac{3}{4}$ inches, the other from $1\frac{3}{4}$ inches to 3 inches. By having one of the large sizes of these bits it is not necessary to buy auger-bits larger than $\frac{3}{4}$ inch. This tool is very convenient for boring large holes, but

is not required, as holes larger than 1 inch in diameter may be cut as described on page 142 and illustrated in Fig. 156. Figure 25 shows a

**Wood Drill Bit.** This is made in $\frac{1}{32}$-inch sizes, running from $\frac{2}{32}$ inch (No. 2) to $\frac{14}{32}$ inch (No. 14). Unless you have an automatic drill a few of these will be required for drilling holes for screws in hard wood. They are very delicate tools and "twist off" very easily, and must not be removed from a hole by reversing the brace, but by continuing to turn it in the same direction, pulling up on the head of the brace at the same time until it has loosened itself.

**Brad-awls** are the simplest and cheapest tools manufactured for making very small holes for nails and screws (Fig. 16). They are sold in various sizes, one or two of which will be useful. A

**Scratch-awl** differs from a brad-awl in the end, which is pointed instead of chisel-shaped. It is used for marking work, but a jack-knife will serve the purpose just as well. A

**Hand Gimlet** (Fig. 16) is also handy for boring small holes.

For countersinking screw-heads below the surface of a piece of wood you should have a

**Rose Countersink Bit** to fit in your brace (Fig. 16). This is used after a screw hole has been bored, and bevels off the edge of the hole enough to let the screw-head drop below the surface.

**A Hand Drill** is a great convenience and time saver (Fig. 26). It can be used for metal and for wood. In wood working it is especially handy for drilling in places where a ratchet-brace cannot be worked. Drills can be obtained for it from $\frac{1}{32}$ to $\frac{1}{4}$ inch, in sets or singly. You should have an assortment of sizes of these drills.

Another handy tool is the combination drill and

**Spiral-ratchet Screw-driver** (Fig. 27). This may be set to drive or withdraw by moving a small *slide* to one end or the other of a slot on the side, or the spiral may be locked to make a ratchet screw-driver by giving the *milled* shell just below the slide a half turn. Three screw-drivers of different sizes are included with this tool, and a *chuck* to hold drills, together with eight sizes of drills, may be purchased for a small additional amount, which makes this tool serve the double purpose of drill and screw-driver. But the spiral-ratchet screw-driver may easily be dispensed with if you have an ordinary 6-inch

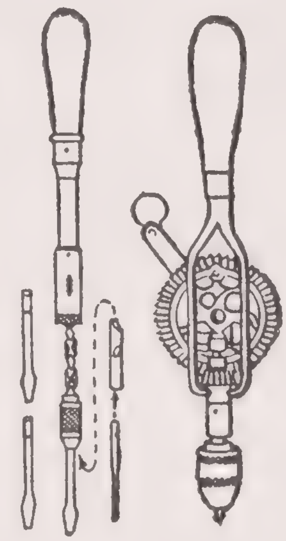


FIG. 27. Spiral-ratchet Screw-Driver. FIG. 26. Hand Drill.

**Hand Screw-driver** and a medium-sized

**Screw-driver Bit** (Fig. 16).

A $\frac{3}{4}$-inch chisel is included in the outfit shown in Fig. 16. This size will be found best for a starter. You will soon require a smaller chisel — one about $\frac{1}{4}$ inch wide,

and when you have advanced with your work you will find that at least five

**Firmer Chisels**, the kind made for ordinary light work, — sizes $\frac{1}{4}$ inch, $\frac{3}{8}$ inch, $\frac{1}{2}$ inch, $\frac{3}{4}$ inch, and 1 inch, — will be necessary. For any very heavy work, such as outside building, you will also require a

**Framing or Mortising Chisel**, which is made stronger for this purpose — $1\frac{1}{2}$ inches or $1\frac{3}{4}$ inches wide. Some firmer chisels are beveled upon the face edges of the blade to make them handy for getting into corners (Fig. 28). For cutting curved grooves and curved surfaces a

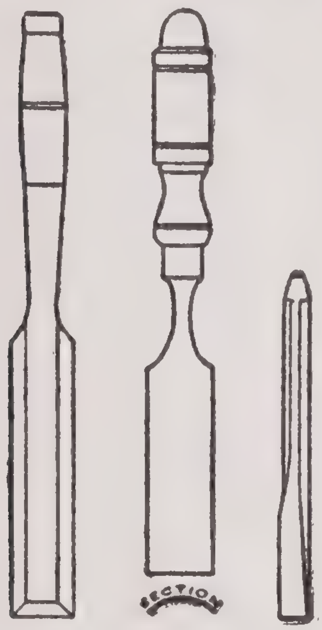


FIG. 28. Beveled Chisel. FIG. 29. Gouge. FIG. 30. Cold-chisel.

**Gouge** is required. This is similar to a chisel except that its blade is curved instead of straight (Fig. 29). A $\frac{3}{8}$-inch and a $\frac{3}{4}$-inch gouge will answer most purposes. Chisel and gouge handles are rounded on the ends for hand use (Fig. 29), but for heavier work, where a mallet is necessary, they should be protected by a leather cap (Fig. 16) or a metal *ferrule* (Fig. 28), to keep the wood from splitting. The chisel or gouge which fits into the handle (Fig. 29) is strong enough for hand use (*paring*), but those made with sockets for the handles to fit into (Fig. 28) are better for mortising and other work where driving is necessary. A

**Cold-chisel** (Fig. 30) is often needed for cutting metal and is a good tool for you to add to your outfit when you can do so.

**A Draw-knife** (Fig. 31) is handy for quickly reducing a narrow piece of wood in thickness and for cutting curved surfaces. It must be used carefully, however, as it will follow the grain of a piece of wood and is apt to split off more than is desired, as is the danger in *paring* with a hatchet. A

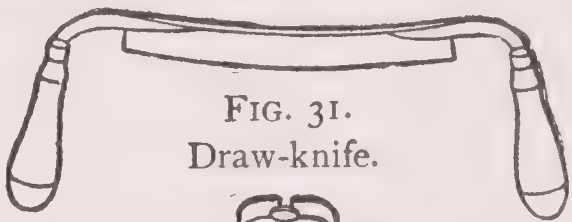


FIG. 31. Draw-knife.

FIG. 32. — Spoke-shave.

**Spoke-shave** (Fig. 32) is used to smooth up a curved surface after it has been roughly cut with a draw-knife, hatchet, or chisel, just as the smoothing-plane is used to smooth up a straight surface. This is not an expensive tool and will be of more use to you than a draw-knife; buy it first.

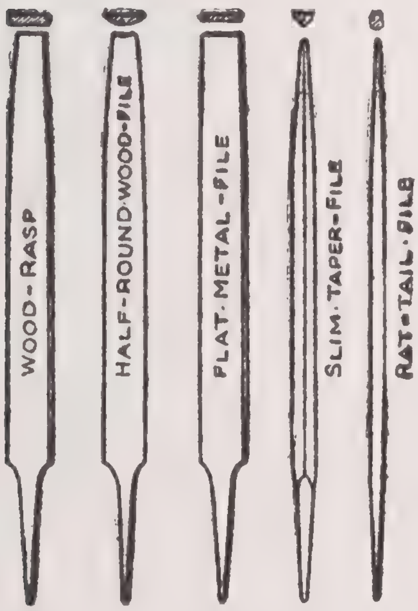



FIG. 33. — Five Handy Forms of Files.

**A Half-round Wood-file or Rasp** may be used for smoothing up all sorts of irregular surfaces and is the best kind to purchase for a small outfit of tools. The

**Handiest Forms of Files** are shown in Fig. 33. The *wood-rasp* is a very coarse file for wood working, while the *rattail file*, the *slim taper file*, and the *flat metal file* are made for metal work. You will find a coarse rat-tail file and a half-round wood-rasp handy

for smoothing curved surfaces after sawing. A thorough sanding is necessary after filing to remove file marks.

**A Zigzag Rule** or a

**Two-foot Folding Rule** (Fig. 16) is required, and either a *try-square* or a *carpenter's square* is necessary for laying out lines at right angles to another line or to the edge of a piece of work, for testing corners to see whether or not they are square, and for testing surfaces for irregularities. The writer prefers a

**Try-square** with a *mitered* handle (Fig. 16), as lines at 45 degrees may be laid out with it. The large size of

**Carpenter's Steel Square** has a *body* (the long end) 24 inches long and a *tongue* (the short end) 18 inches long; but a smaller size with a body 18 inches long and tongue 12 inches long (Fig. 16) will serve your purpose just as well and will be cheaper to buy and lighter to handle.

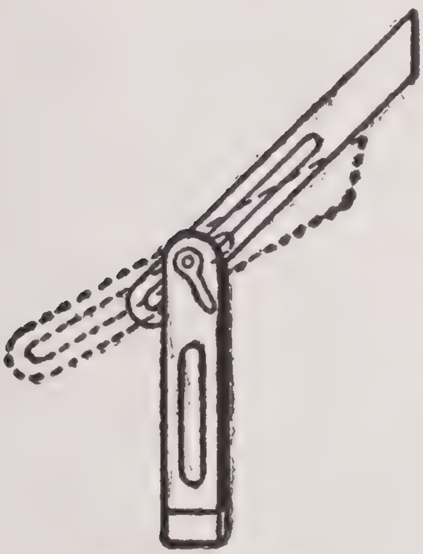


FIG. 34. — Bevel.

**A Bevel** (Fig. 34) is a handy tool for laying out angles other than 45 degrees, for laying out bevels, and for reproducing angles upon several pieces of work. It is like a try-square, only instead of being fastened rigid it is made adjustable. You can easily do without this tool for ordinary work, but it will be useful when you get into advanced work.

**A Marking-gauge** (Fig. 16) consists of a block of wood (the *head*) through which slides a graduated stick (the

*bar*) with a point (the *spur*) near one end (see Fig. 68, page 52). The head may be set to any desired distance from the spur, then by placing the head against the edge of a piece of work and pushing the spur along the surface, a line can be scratched which will be exactly parallel to and at the required distance from the edge. The ordinary marking-gauge has only one spur; that shown in Fig. 68 has two spurs, is what is known as a *mortise-gauge* (see "Gauging," page 52), and is the better form to buy.


FIG. 35. Wing Dividers.

**Wing Dividers** (Fig. 35) come in handy for a number of operations, but are used principally for describing circles and laying off measurements. The *thumb-screws* make it possible to adjust the dividers very accurately to any desired measurement. Until you can get a pair of these you may use a stick with a couple of nails driven through it, or a piece of cardboard with a pencil and pin pushed through it, for a compass, and measurements may be laid off by means of a *rule*, a *straight-edge* (a stick with a straight edge), or a piece of paper.[1]

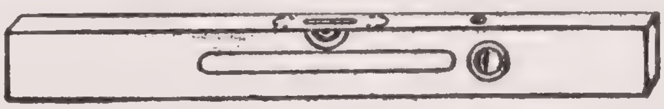


FIG. 36. — Spirit Level.

**A Level** (Fig. 36) is necessary in building construction to help the mechanic get his work *plumb* and

[1] A simple method for dividing a distance into a number of equal spaces by means of a rule and pencil is shown upon page 46 of "The Boy Craftsman."

*level*, but it is useless in the shop unless you level up whatever your piece of work rests upon before testing.[1] But a

**Pocket Level** (Fig. 37) is handy for getting approximate levels and is cheap enough so every boy can own one.

FIG. 37. — Pocket Level.

A tool with which ten different operations can be performed is the

**Odd-jobs** shown in Fig. 38. Besides the three operations indicated in the illustration, it may be employed as a *marking-gauge*, a *mortise-gauge*, a *depth-gauge*, a *try-square*, a *T-square*, a *scratch-awl*, and a *rule* (a 12-inch ruler comes with the tool). The many purposes for which this tool may be used make it a handy one to carry about for "odd jobs."

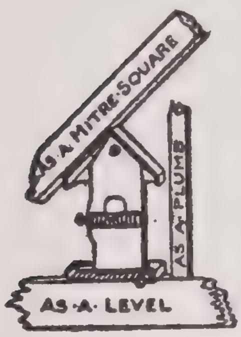



FIG. 38. — Odd-jobs.

**A Pair of Cutting Pliers** (Fig. 16) will serve as pincers and nippers. Besides these you will often be in need of a

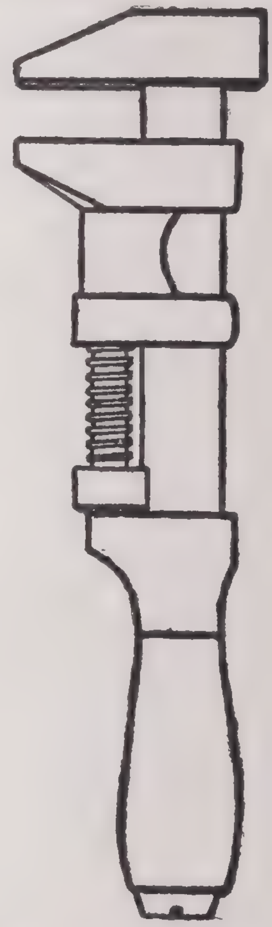


FIG. 39. — Wrench.

**Wrench** (Fig. 39) for tightening and loosening nuts, and other operations; this will be a good addition to make to your outfit when you can afford it.

[1] A satisfactory home-made *plumb-board* for large work is described on page 153.

For holding together glued-up work until the glue has *set* a pair of

**Wood Handscrews** (Fig. 40) are handy, as are also a pair of

**Cabinet-maker's Clamps** (Fig. 41) for holding wide glued-up pieces; but you can dispense with both of these by providing yourself with several

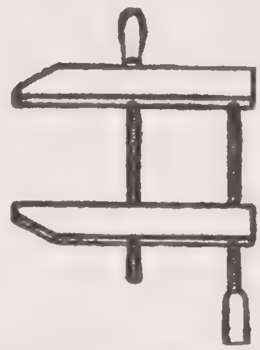


FIG. 40. — Wood Handscrews.

FIG. 41. — Cabinet-maker's Clamps.

**Home-made Clamps** of different lengths similar to those shown in Fig. 42. These consist of two strips with two blocks of wood *A* and *B* screwed to them 4 or 5 inches farther apart than the width of the glued-up piece of work. Taper the inner edge of blocks *A*, but leave that of blocks *B* square. The work is laid upon the strips with one edge against blocks *B*, then a strip is placed against its other edge for a *filler*, and a pair of wedges

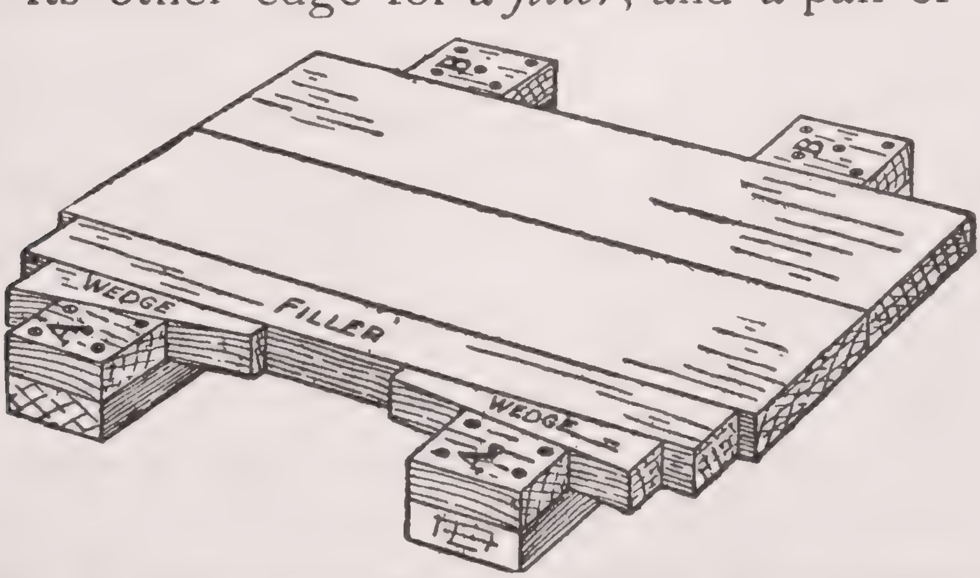



FIG. 42. — Home-made Clamps for Holding Glued-up Work.

with one edge square and the other cut to fit the taper on the edge of blocks *A* are driven in between the filler and the blocks. Care must be taken to prevent the edges or the center of the work from springing up, when "driving home" the wedges, or the surface will be *winding* when the work is removed.

You ought to have

**A Carborundum Stone.** One of the household size will do. It will serve for shop tools and kitchen cutlery. Belt the stone to a motor, or rig up a treadle for foot-power.

You must have a good

**Oilstone.** Of the manufactured stones the India oilstone is being very extensively used, while the Lily-white and the Rosy-red Washita oilstones are two of the best natural stones on the market. Besides an oilstone you must of course have an

**Oiler** and a bottle of sperm-oil — or bicycle, automobile, or sewing-machine lubricating oil.

If you have not built tool drawers in the ends of your work bench (Figs. 6 and 7), you must make a chest or cabinet as soon as possible to protect your tools from injury and from being borrowed without your permission.

When the author received his first outfit of tools as a boy, he made

**A Tool-chest** out of an old grocery box, this being the best material at hand; and as it was such an easy matter to turn this box into a chest and it served the purpose so well he has decided to tell you boys how to make one

just like it. Figure 43 was drawn from this old chest, which the author still has in his possession. The box used was, approximately, 26 inches long, 13 inches wide, and 9 inches deep, but yours need not be of these exact

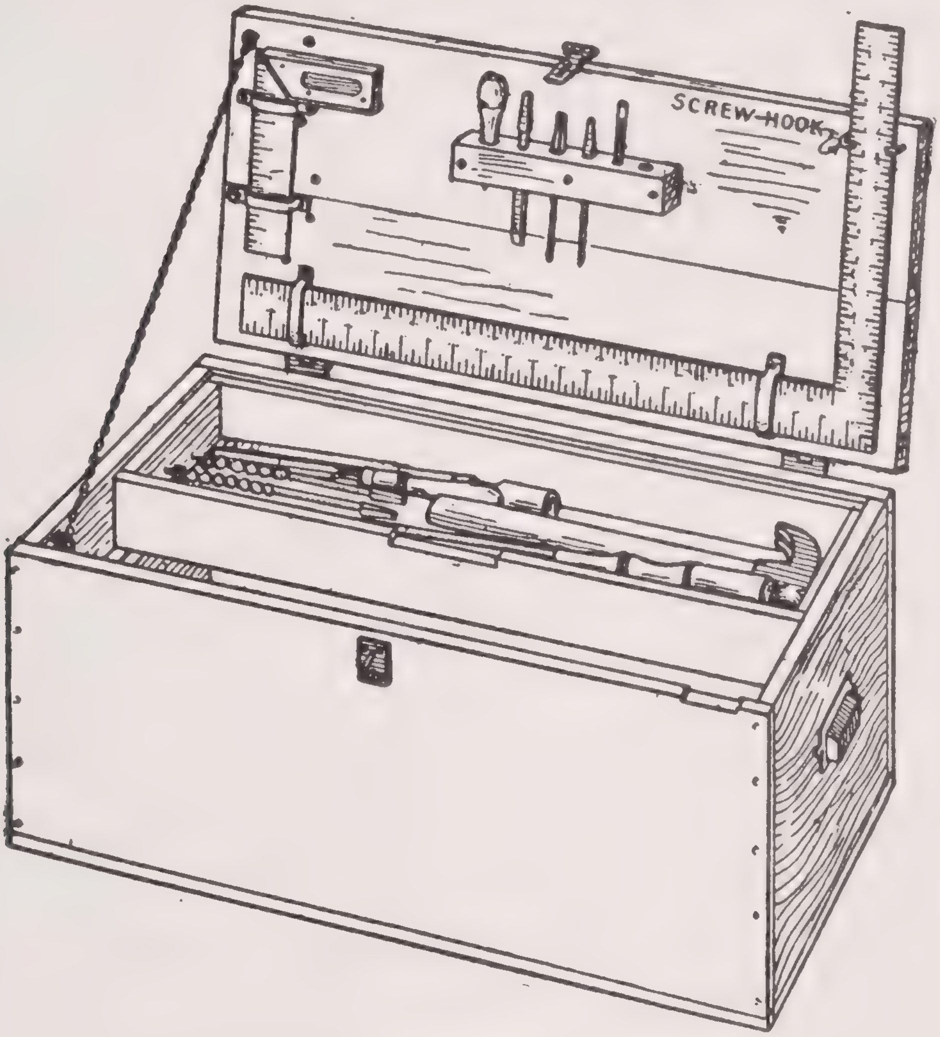



FIG. 43. — A Grocery-box Tool-chest.

dimensions, only be sure it is long enough to accommodate your large tools.

After selecting your box, renail all loose boards and replace any that happen to be split with pieces from another box. Fasten together the cover boards with a *batten* at each end (*A*, Fig. 44) and hinge to the box with a pair of strap-hinges as shown. Buy a hinge-hasp

and staple (Fig. 45) and a pair of drawer-pulls at a hardware-store, screw the hasp to the box cover and the staple to the box, and screw the drawer-pulls to the ends of the box for handles. As a check to prevent the cover from dropping too far back, attach a chain to two screw-eyes screwed into the cover and the box. The tray is removable and rests upon two *cleats* or strips nailed to the ends of the box. Make this tray $\frac{1}{4}$ inch shorter than the box, 7 inches wide, and $1\frac{1}{2}$ inches deep (inside), and put the bottom, sides, and ends together in the same way that a box is made.

Fig. 45.
Hinge-hasp and Staple.

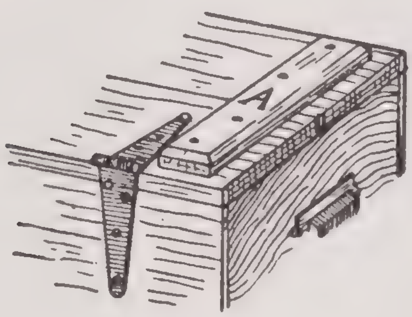



Fig. 44.
How to hinge the Cover.

Fasten a block with holes of the proper size drilled in it to the inside of the cover, in which to stick such tools as the brad-awls, screw-driver bits, wood drills and nail-sets, and tack some loops of leather to the cover for the squares to slide in. The upper end of the carpenter's square is held by a couple of screw-hooks, and is released by giving one hook a quarter-turn. The small tools — the chisels, auger-bits, screw-driver, etc. — should be kept in the tray, and the large tools — the saw, planes, bit-brace, etc. — in the bottom of the chest. Notch the top edge of the box and tray, if necessary, to accommodate the tools on the cover.

When you have completed your chest, sandpaper it

well, then give the inside and the tray a coat of boiled linseed-oil and the outside a coat of paint or oil stain.

A plan for an easily made

**Tool Cabinet** is illustrated and described in "The Boy Craftsman." This is a very simple affair made out of a box with the cover boards battened together for a door. The author has been asked for a plan for making a paneled door for a cabinet, and as others of you may also wish to panel the door, he suggests that you build a frame of 1-by-2 strips and set in a panel of wallboard or plywood. Rabbet or groove the inner edges of the strips (Fig. 75) for the panel. You may mortise and tenon the ends of the frame strips (Fig. 74), or butt them together.

A tool cabinet is the handier receptacle for keeping tools within easy reach; but a chest is to be preferred if the tools must be carried about, which is often necessary where the shop is located in a damp place, to keep them from rusting. In case you make a chest,

**A Tool-rack** on the wall back of the bench is a good arrangement for holding the tools while you are working. In the photograph opposite page 2 is shown such a rack, and Fig. 46 shows how it may be put

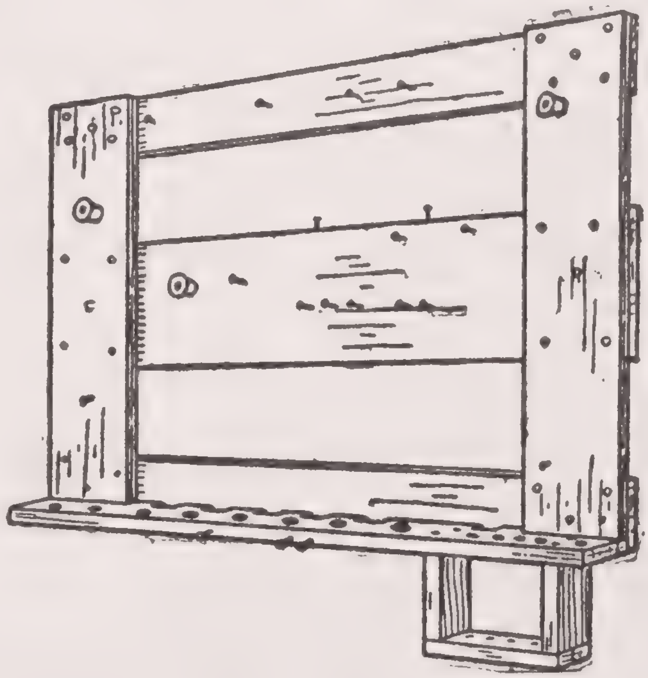


Fig. 46. — A Tool-rack.

together. The chisels, auger-bits, wood drills, awls, and screw-driver stick into the holes bored through the bottom shelf, and the ends of the small bits are supported by a small bracket fastened below the shelf. Nails and spools hold the other tools. In the same photograph you will see how boxes may be bracketed to the wall for

**Open Shelves** for your paint-cans, varnishes, and other supplies, and how a shelf may be supported above the rack for miscellaneous articles; also how the under part of the work bench may be utilized for

**Material Boxes** by fastening boards across the rails to hold them.

Nails and screws should be kept in some kind of order, so the sizes wanted may be got quickly without unnecessary hunting, and several receptacles for these are shown in Figs. 47 to 52. The **Partitioned Nail Box** (Figs. 47–49) will hold six different lengths of nails. Cut the back and bottom (*A* and *C*, Fig. 48) 3 feet long by 8 inches wide, the front (*B*) the same length by 5 inches wide, and the partitions and end pieces (*D*, Fig.

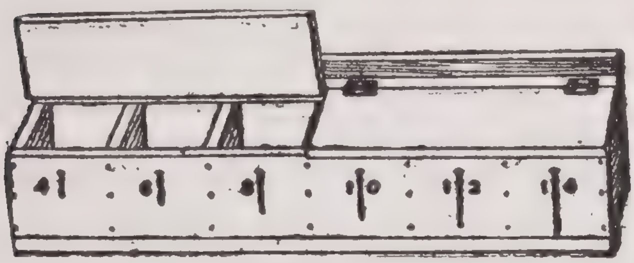


Fig. 47.

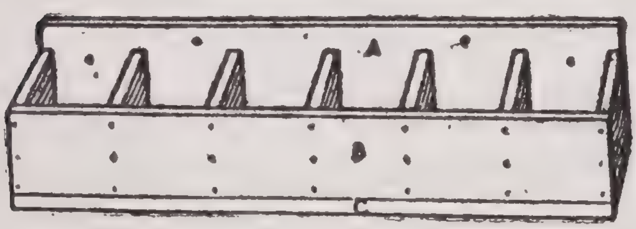



Fig. 48.

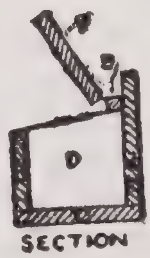



Fig. 49.

Figs. 47–49.—Details of Partitioned Nail Box.

49) 6 inches wide by 6 inches high at the back and 5 inches high at the front. Nail together the front, back, and end pieces, then nail on the bottom and fasten the partitions in place so as to divide the box into six equal spaces. The box may either be screwed to the wall or hung upon hooks. If you screw it, do this before putting on the cover. Cut the hinge-strip (*E*, Fig. 49) 1 inch wide by the length of the box and nail it in place to the partition tops. The cover may be made in one piece, or in two as in Fig. 47; hinge it to the hinge-strip. Mark the sizes of the nails upon the front of the box, and fasten nails of corresponding sizes in front of the receptacles with small staples or bent-over brads to help you to associate the lengths with the size numbers. This box has been planned for *common nails* and to hold sizes ranging from $1\frac{1}{2}$ inches to $3\frac{1}{2}$ inches long (4-penny to 16-penny).

**Another Box** may be made to hold *finishing-nails*, papers of brads and tacks, and *spikes* (20-, 30-, 40-, 50-, and 60-penny nails). *Bolts* and *screws* may be kept in a third box.

Empty tin cans and cigar boxes are easy for any boy to get and make excellent

**Receptacles for Nails, Screws, and Brads**. There is a can with a removable lid in which molasses and sirup comes (Fig. 50) that is very handy, and baking-powder cans and even tomato cans, made clean by washing, with the opened ends removed, or the cut edges hammered flat,

will serve the purpose. The cans may be hung up side by side on the wall, if mounted upon pieces of board provided with screw-eyes or holes (Figs. 50 and 51). To mount the cans, punch four holes through each and wire them to pieces of board as shown in Fig. 51. Cigar boxes may be fastened upon wooden brackets as shown in Fig. 52.

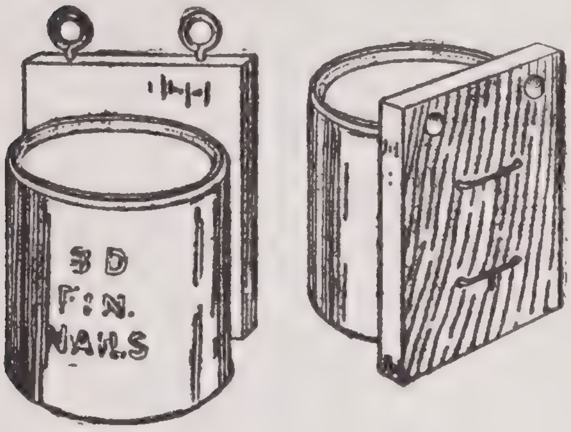



FIG. 50. FIG. 51.
FIGS. 50 and 51.— Can Receptacles for Nails, Brads, and Screws.

After you have fitted up your workshop with a bench, shelving, racks, and receptacles, and made a chest or cabinet for your tools, there are still a number of pieces of equipment to construct before you will be ready to open up your shop for business.

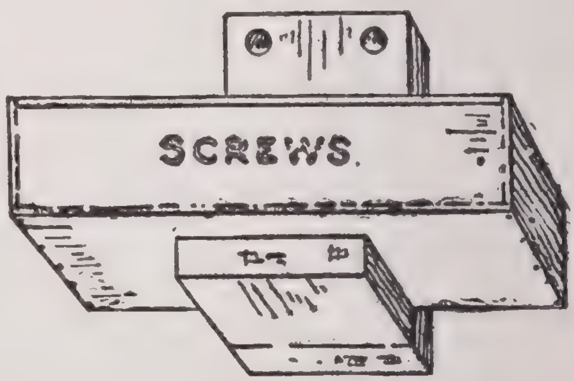



FIG. 52.— Cigar-box Receptacles for Screws, Bolts, or Miscellaneous Hardware.

Figure 53 shows

**A Horse** which is very much handier than the simpler forms of carpenters' horses, in so far as the board top gives a broader surface to lay work upon and the shelf underneath makes a convenient place to lay saws and other tools. This horse is very commonly used by carpenters. Details for its construction are shown in Figs. 54, 55, and 56. Cut the body *A* 3

feet 10 inches long out of a piece of 2-by-4, and cut the four legs *B* to the dimensions shown in Fig. 55 out of 1-inch stuff, with one edge tapered $\frac{3}{4}$ inch. Trim off the upper ends of the legs as shown in Fig. 56, so when the legs are nailed to the body the lower ends will be 16 inches apart. Nail the legs in place about 5 inches from the ends of the body, then cut the end rails (*C*, Fig. 54) and the side rails *D* 3 inches wide and of the required length and nail them to the legs 9 inches below the body.

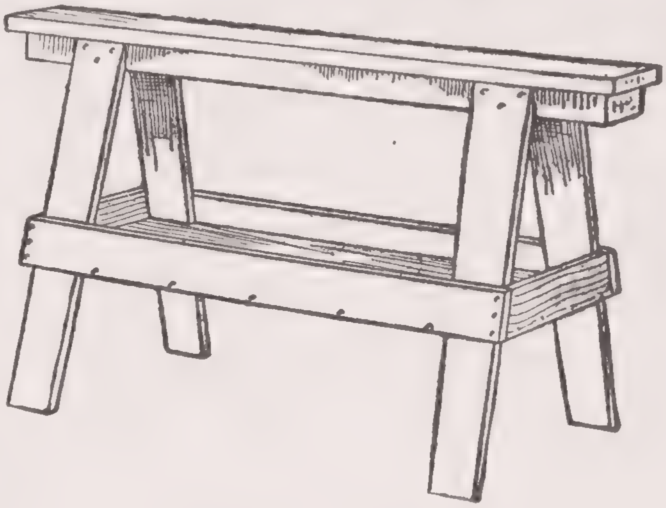


FIG. 53. — Horse.

Cut the tray bottom boards to fit between the rails (*E*, Fig. 54) and fasten them with nails driven through the rails into their edges. Cut the top board *F* 4 feet long out of 1-inch stuff and screw it to the body, countersinking the screw-heads as a protection to your edge tools.

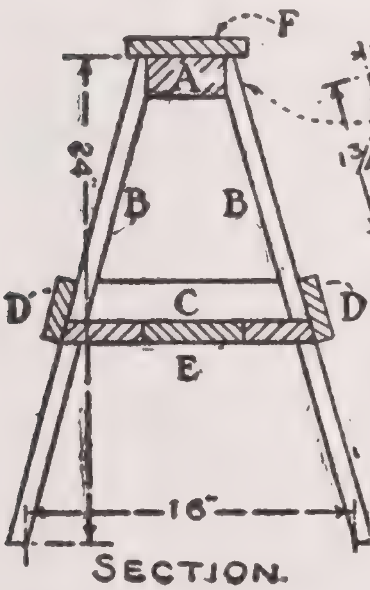



FIG. 54.

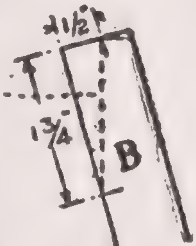



FIG. 56.

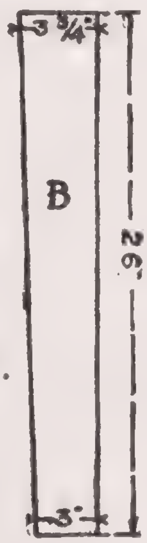



FIG. 55.

FIGS. 54–56. — Details of Horse.

When the horse has been nailed together, you will probably find that it does not stand evenly — at any rate, the legs will not be cut to the right angle on the bottom

and will not rest squarely upon the floor. To allow for trimming, an extra inch was added to the length of the legs, in the leg pattern (Fig. 55). Set the horse in the place it will occupy in your shop, so in case the floor is out of level the horse may be made to stand evenly in that place, locate the short leg, and put a chip under it so as to level up the top; then take a block of wood about 1 inch thick, slide it around the bottom of each leg, and mark a line across each face even with the top of the block. Saw the legs off on these lines; and if the work has been done carefully, the horse will stand perfectly even. If you find that the horse is too high after completing it, it will be an easy enough matter to trim off the legs as much as is necessary to make it suit your height.

You should have two horses in your shop across which to lay long pieces of work for marking and sawing. Of course a couple of packing boxes may be used until you have plenty of time to make these. You will also find that a chair will serve the purpose of

**A Saw-bench** for small work about as well as a horse would. Such usage will be rather hard on the chair, however, unless the seat is protected in some way, so if you want

**A Chair Saw-bench**, prepare a wooden cover that can be placed over the seat as shown in Fig. 57. Make this cover 20 inches long and 16 inches wide; fasten the boards together at the ends with battens of just the

thickness of the chair seat and fitted to the curve or slant of the seat (*A* and *B*, Fig. 58), and screw a wooden button to each batten. Place several thicknesses of cloth over the chair seat, then set the cover over it and turn the buttons so as to hold it in place. You may protect the back by slipping a potato sack over it.

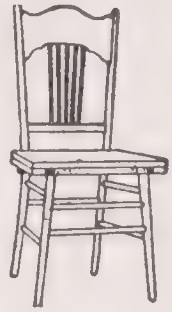


FIG. 57. A Chair Saw-bench.

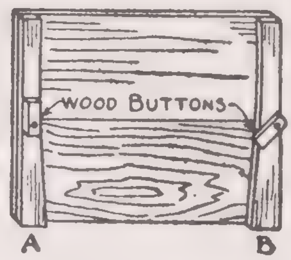



FIG. 58. Cover to protect Chair.

It is necessary to have a miter-box to guide your saw in making *miters*. The adjustable iron boxes now manufactured are the most satisfactory kind, but they are rather expensive to buy and probably will not serve your purpose any better than

**A Home-made Miter-box** such as the average carpenter makes for his own use (Fig. 59). This box may be made of pine. Cut the bottom piece 4 inches wide and 14 inches long out of a $1\frac{1}{4}$-inch board, and the sides 5 inches wide and 14 inches long out of 1-inch stuff, and nail the sides to the edges of the bottom. Then take the box to a carpenter and ask him to make two *miter cuts* and one 90-*degree cut* in the sides. The method of laying out and cutting the miters is described in "The Boy Craftsman"; but, unless you have had

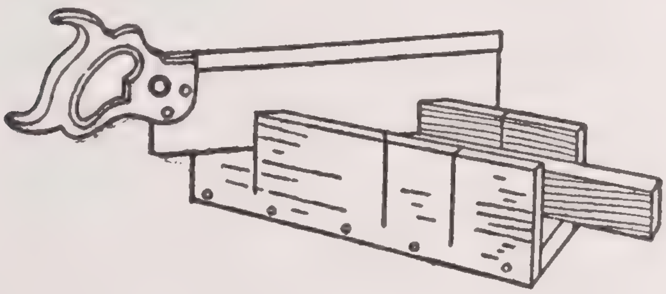


FIG. 59. — Home-made Miter-box.

enough practice in sawing so you can saw very accurately, you had better have a carpenter cut these for you.

**A Bench-hook** (Fig. 60) is used for a number of operations. For paring with your chisel and chopping with your hatchet it furnishes protection to the bench top, which would otherwise be cut up badly in a short time; it is handy to lay sticks and other small pieces on for sawing with the back-saw, and by making a right-angle *kerf* (slot made by a saw) and a right- and a left-hand mitered kerf in the *stop* strip it may be used for sawing small work accurately. Make the bench-hook out of a piece of board about 12 inches square, and nail the *hook cleat* to the under side of one edge and the mitered stop to the opposite edge as shown. The kerfs in the stop strip may be laid out with a mitered handle try-square (Fig. 67, page 52), but it will be easier to cut them in a miter-box.

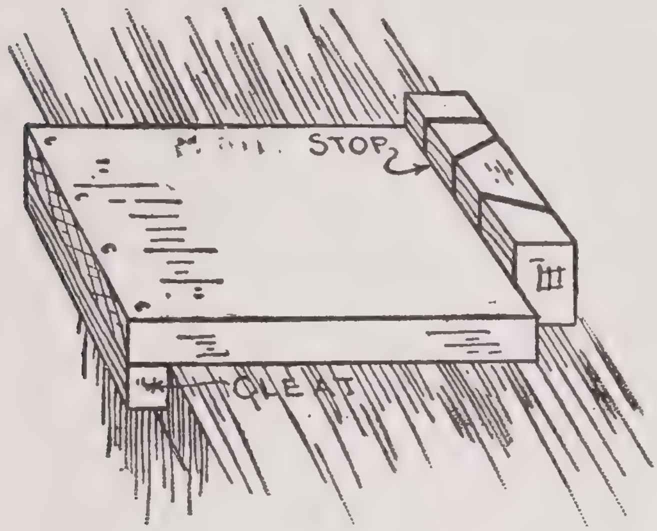



FIG. 60. — Bench-hook.

The operation of truing the edge of a board is known as *jointing* or *shooting*, and to hold the work and guide the plane while shooting short, narrow pieces of work,

**A Shooting-board** is generally used. Figures 61 and 62 show the construction of one of these. Cut the pieces out of 1-inch stuff, *A* 11½ inches wide by 24 inches long,

*B* $7\frac{1}{2}$ inches wide by 24 inches long, *C* 2 inches wide by $7\frac{1}{2}$ inches long, and *D* 2 inches wide by 24 inches long. It is necessary to have the faces and edges straight and true in order to make it possible to true up other pieces of work by means of a shooting-board. Bevel off the lower right-hand edge of *B* (Fig. 62), then nail or screw it to board *A* with the left-hand edges flush. Nail strip *C* to *B* so that its end is exactly at right angles with the right-hand edge of board *B*. Nail strip *D* to the left-hand edge of board *A*.

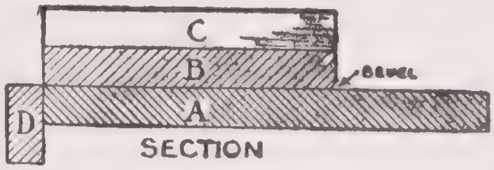



FIG. 62.

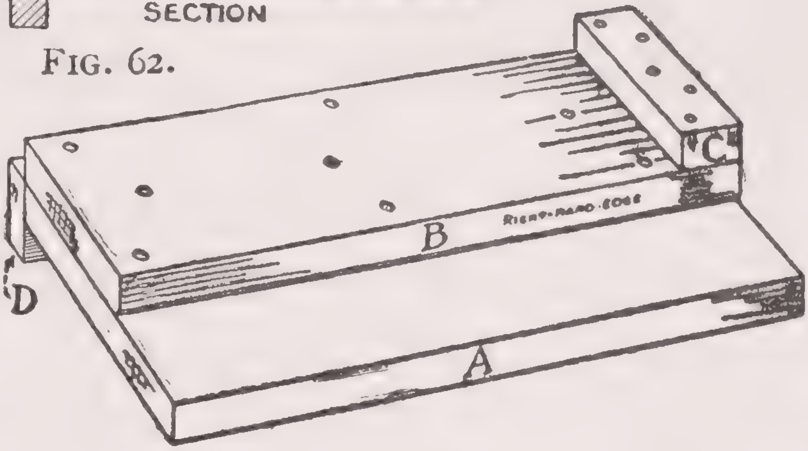
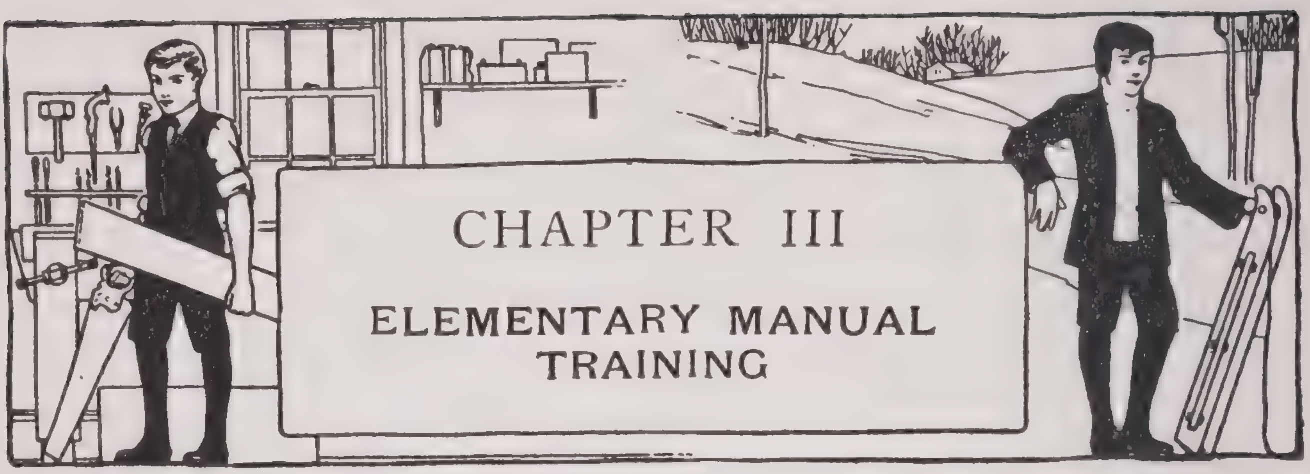



FIG. 61.

FIGS. 61–62. — Shooting-board.

In using the shooting-board, it is placed upon the bench with strip *D* close against the bench apron and the end of board *A* shoved against the bench-stop, then the board to be *jointed* is placed upon board *B* with one end against *C*, which forms a stop, and the edge to be planed projecting over the right-hand edge of board *B*; with the plane turned on its side upon board *A* it is then worked back and forth until the edge has been planed off accurately. The bevel on the edge of *B* forms a groove which keeps small shavings from getting in the way of the plane and throwing it out of line.




# CHAPTER III

## ELEMENTARY MANUAL TRAINING

MANY of you boys are studying manual training and learning the use of wood-working tools, how to select material, and how to lay out a project and carry the work to completion. The time alloted to shop work, however, is generally too short to satisfy that insatiable desire a fellow has to make things. The solution is to be found in a home workshop. The instructions in this chapter have been prepared to supplement school instruction, and to serve as a substitute to boys to whom school manual-training is not available.

There are all sorts of things which the average boy can construct without having had instruction in the making of wood joints, and in putting together an article and finishing it, but for any particular work, such as the making of furniture and things which you wish to sell or give away, you must understand how to proceed in order that the work may not only be substantially constructed, but be pleasing to the eye as well. The suggestions and pointers presented in this chapter are intended to help you to attain these results, and those of

you who are studying manual training will do well to read over the instructions, as you will likely find something new among them which will aid you in carrying out the work described in succeeding chapters.

Every boy should, first of all, know something about the

**Selection of Working Material.** The softer woods are better for the beginner to use, as they are easier to work. Of these, pine, cypress, spruce, fir, poplar, redwood, whitewood, and basswood are probably best adapted to amateur work. The selection depends largely upon the locality, certain varieties being easier to procure in one place than another. Clear white pine is the choicest of the soft woods for model-making, but it has become so scarce that it is practically out of the market. What is sometimes sold for white pine is sugar pine. Cypress is another very easily worked wood; the California redwood is also good, and can be had in very wide boards; and whitewood (from the tulip tree) and basswood (from the linden tree) furnish excellent working material. Whitewood and poplar are close-grained, and well adapted to stain, enamel, and lacquer finishes. Their tendency to warp is great, but warping may be prevented by cleating on the ends or under side. Basswood is obtainable in large plywood panels. Because the plies are placed with the grain crossing, there is less chance of plywood's warping than boards of the same thickness. Basswood plywood is desirable for jig-saw projects.

Of the hard woods, oak is best suited to the work of the amateur craftsman. It is easily worked, and easier to finish than many of the more expensive woods. Oak takes stain readily, and an attractive finish is obtained by staining, without filling, shellacking and then waxing, or varnishing with flat varnish. Ash, chestnut, cherry, birch, mahogany, and walnut are other woods which you may use. Mahogany and walnut are well adapted to lacquer finishes. But lacquer dries too rapidly to make a brushed-on job satisfactory, unless the surfaces are very small. You will find a satin-finish enamel better suited to your work.

Many of you boys have seen how logs are cut up into boards, planks, and heavier pieces, but it will be well for all of you to know something about the

**Structure of Wood** and how this must be taken into consideration in converting the log into lumber, as it will enable you to select and handle your material more intelligently. Figure 63 shows a *cross-section* of a log. In the center, or generally a little to one side of the center, is a circular core known as the *pith*, then surrounding this is a series of circles known as *annual rings*, and around the outside is the *bark*. The wood between each two rings represents the amount of one year's growth, and the annual rings are produced as a result of the suspension of growth during autumn and winter. By counting the rings it is very easy to determine the age of a tree. The inner portion of the tree is known as the

*heart-wood* and supplies the more solid and desirable material (unless the tree has started to decay, when the first signs are generally to be found here), while the outer wood is known as the *sap-wood*, as it contains the greater portion of the tree's juices. In the cross-sections of logs (Figs. 63 and 64) you will notice a series of lines radiating from the pith, some extending as far as the bark and others running but part way. These, called the *medullary rays*, are a peculiar formation in a tree and produce what is known as *silver-grain* upon the surface of all *quarter-sawed* wood. The tree structure must be taken into consideration in

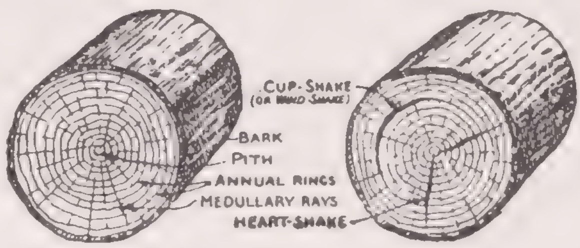



FIG. 63. Tree Structure.

FIG. 64. Cracks in Logs.

**Cutting up the Log**, and different methods of sawing are employed according to the purpose for which the wood is to be used. The common method of *plain sawing* is shown in Fig. 65. With this the only waste produced is in the sawdust and bark removed. But you will notice, by looking at the illustration, that with the exception of one board taken through the center of the pith, the annual rings cross the boards obliquely; this is the cause of *warping*. When wood drys out (*seasons*), the greatest amount of

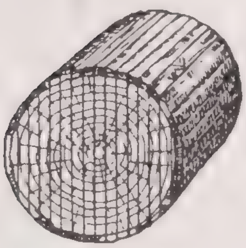


FIG. 65. Plain-sawed.

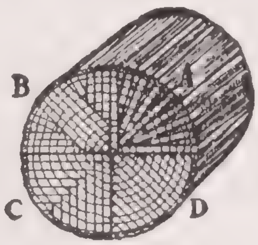



FIG. 66. Quarter-sawed.

shrinkage occurs along the line of the annual rings, therefore the longer the arc of the ring crossing the cross-section of a board, the greater the shrinkage along that arc will be, and plain-sawed stuff, having arcs of different lengths crossing it, will shrink unequally and warp as the result. Warping is more noticeable, of course, in wide than in narrow boards and must be taken care of by *cleating* or some other method of holding the wood in position.

The board cut from the center of the log in plain sawing is the only one which will show the silver-grain to a marked degree. To get this effect upon every board

**Quarter Sawing** is necessary (Fig. 66). The log is first sawed into quarters, then each quarter is sawed up radially so the surface of each board will be parallel with the medullary rays. Strictly speaking, the quarter marked *A* shows the only proper method of quarter sawing, as it is the only one in which each board is parallel with the rays, but methods *B*, *C*, and *D* are also used, as they save considerable waste of material, and boards so cut are sorted into different grades. The big waste, and the fact that more time is required in the cutting, make quarter-sawed stock much more expensive than plain-sawed stuff. The irregular pieces cut from between the boards are usually utilized for moldings and other small pieces, and this reduces the amount of waste somewhat. Besides the beautiful markings, quarter-sawed boards

have the advantage of uniform shrinkage and are not likely to warp.

*Knots*, *cup-shakes*, *heart-shakes*, and *checks* are defects occurring in logs and produce a big waste in the manufacture of lumber. The portions containing these are either cut away or, where not very marked, the boards cut from them are sorted into the poorer grades of lumber. First and second grades generally admit boards with small, sound

**Knots,** — pin knots and standard knots, — but if you go to a lumber yard or mill for your material, you will probably be allowed to pick out pieces from the pile which are *clear* or which have knots in places where they can easily be cut out without spoiling the boards for your purpose. Cracks, however, such as

**Cup-shakes and Heart-shakes**, the former being cracks between the rings and the latter cracks along the medullary rays (Fig. 64), should not appear upon any boards but those of the poorest grade of lumber, so do not let a dealer pass them off on you for first-grade stuff. Boards are likely to split at the ends through drying out unevenly, and these rifts are known as

**Checks.** Very long checks extending entirely through a board are not admitted in first grades, but *checking* is likely to occur even after the piece has *seasoned* for a long time and is a common fault with large timbers where the outside dries out long before the center.

After the boards have been cut, it is necessary that the

sap be evaporated before they are fit to use. The two methods employed are known as

**Seasoning**, which consists in piling up the boards in large piles in the open, with narrow strips of wood placed between each layer to allow a free circulation of air throughout the pile, and leaving them in this position for from two to four years, and

**Kiln Drying**, the best method of which consists in piling up the lumber in a similar manner in large chambers or *kilns* and passing condensed steam through and around the boards for a period of two weeks, to open up the pores and cause the water to run out, and then shutting off the steam and passing a forced circulation of heated air through them for another two weeks. The latter method is employed on lumber used for fine furniture; but as a rule material for ordinary purposes remains in the kilns not over forty-eight hours, and often a much shorter time than this. The slower the process of drying, the better it is for the wood, for the reason that rapid drying destroys much of the elasticity and toughness. On this account and for the fact that kiln-dried stock is more sensitive to atmospheric changes, weather-seasoned lumber is much to be preferred.

Lumber is spoken of as

**Stock or Stuff**. As produced from a log, it is known as

**Undressed Stuff**, and when the roughness left by the saw has been removed by the planer, it is called

**Dressed Stuff** (specified *D* upon material bills). If only one side is smoothed, it is said to be *surfaced-one-*

*side* (marked *S-1-S*); if two sides and one edge, *surfaced-two-sides-and-one-edge* (marked *S-2-S-&-1-E*), etc.

*Tongued-and-grooved boards* (Fig. 75) are known as

**Matched Stuff** (specified *M*), and when they are also beaded, they are said to be

**Matched-and-Beaded** (specified *M-&-B*). The beaded material is called *ceiling*, and is used for porch ceilings, backs of pantry cases, wainscotings, etc.

Lumber up to 2 inches thick (undressed) is known as

**Boards**, when 2 inches or more in thickness as

**Planks or Dimension Stuff**, and when four inches or more, it is called

**Timber**

**Stock Sizes of Lumber.** Boards are reduced $\frac{1}{8}$ inch in thickness and $\frac{1}{4}$ inch in width from the original dimensions in the process of dressing, which must be taken into consideration in laying out work. In some localities this is allowed for in cutting up the log, but as a rule it is not. Thus, a board 1 inch thick and 12 inches wide, in the rough, would be $\frac{7}{8}$ inch thick and $11\frac{3}{4}$ inches wide when dressed, but as a matter of fact all 1-inch stock is now being sawed about $\frac{1}{16}$ inch under 1 inch, and as a result is only $\frac{13}{16}$ inch thick when dressed. Stock 2 inches or more in thickness is reduced $\frac{1}{4}$ inch in dressing. Thus, a 2-inch by 4-inch piece is only $1\frac{3}{4}$ inches thick and $3\frac{3}{4}$ inches wide when dressed.

To avoid the use of fractions as much as possible, stock is generally known by its undressed dimensions, as follows:

1-by-12-inch stuff, 2-by-4-inch stuff (or simply 2-by-4's), 1-inch stock (generally spoken of as $\frac{7}{8}$-inch stock, which originally was the dressed thickness), etc. The regular thicknesses of dressed lumber are: $\frac{3}{8}$ inch ($\frac{1}{2}$-inch stock), $\frac{5}{8}$ inch ($\frac{3}{4}$-inch stock), $\frac{13}{16}$ inch (1-inch stock), $1\frac{1}{8}$ inches ($1\frac{1}{4}$-inch stock), $1\frac{3}{8}$ inches ($1\frac{1}{2}$-inch stock), $1\frac{3}{4}$ inches (2-inch stock), etc., the widths are $1\frac{3}{4}$ inches (2-inch), $3\frac{3}{4}$ inches (4-inch), $5\frac{3}{4}$ inches (6-inch), $7\frac{3}{4}$ inches (8-inch), etc., each succeeding width increasing 2 inches, and the standard lengths run from 10 feet to 20 feet in even numbers.

**In Purchasing Material**, if there is not a mill or lumber yard near by where you can go and place your order direct, you can probably arrange with a friendly carpenter to buy your stock for you when he is purchasing some for himself. Make out

**A Mill List** with the number of pieces of each size desired, the kind of wood, the dimensions (place the thickness first, then the width, and last the length) and the directions for *dressing*, *matching*, *beading*, etc., in the following order: —

| Pieces | Material | Dimensions | Remarks |
|---|---|---|---|
| 12 | Red Oak | $\frac{1}{2}'' \times 3'' \times 12'\ 0''$ | M-&-B Ceiling |
| 4 | " " | $1'' \times 10'' \times 12'\ 0''$ | S-2-S |
| 4 | " " | $1\frac{1}{4}'' \times 12'' \times 10'\ 0''$ | S-2-S-&-1-E |
| 4 | Whitewood | $1'' \times 12'' \times 16'\ 0''$ | S-2-S |
| 10 | Cypress | $1'' \times 10'' \times 12'\ 0''$ | S-2-S |
| 2 | Yellow Pine | $2'' \times 4'' \times 16'\ 0''$ | S-4-S |
| 1 | " " | $2'' \times 10'' \times 18'\ 0''$ | S-4-S |

Lumber is sold by the thousand feet (per M), so after finding the existing retail price it is an easy matter

**To Estimate the Cost** of your material. A piece of board 1 inch thick, 12 inches wide, and 12 inches long is figured as a *board foot.* Upon this basis a piece 1 inch by 4 inches by 12 feet would contain 4 board feet, and a piece 2 inches by 4 inches by 12 feet would contain 8 board feet. Any thickness under 1 inch is figured the same as 1-inch stuff. The retail price ordinarily covers *dressing*, but *matching*, *grooving*, *rabbeting*, *beading*, and other machine work is extra.

Before attempting any shop cabinet making, a boy should spend some time in getting accustomed to handling his tools properly, so as to be able to lay out work accurately, plane up a surface true and smooth, and saw to a line. "The Proper Handling of Tools" is described in "The Boy Craftsman," and it is not my intention to repeat these instructions here, only so far as it is necessary to show the right way to lay out a piece of work, to cut and join its various parts, and to finish its surface.

**Laying Out Work.** Unless you lay out a piece of work accurately, you cannot expect to turn out a satisfactory job, because nothing will fit, and if you are careless at the start, you will likely be careless in the other operations as well. To guard against mistakes, it is always best to check up measurements as you go along. Use a 2-foot rule or a carpenter's square with which to lay off measurements, and a carpenter's square or try-square for *scrib-*

*ing* lines between points and carrying them around the four sides of a piece of work. (See Fig. 67; also *Planing Exercise* on page 54.) A sharp lead-pencil may be used for scribing, but the work can be done more accurately with a jack-knife; however, a knife line can be made only upon surfaces where it will be removed by cutting or concealed by another piece of wood.

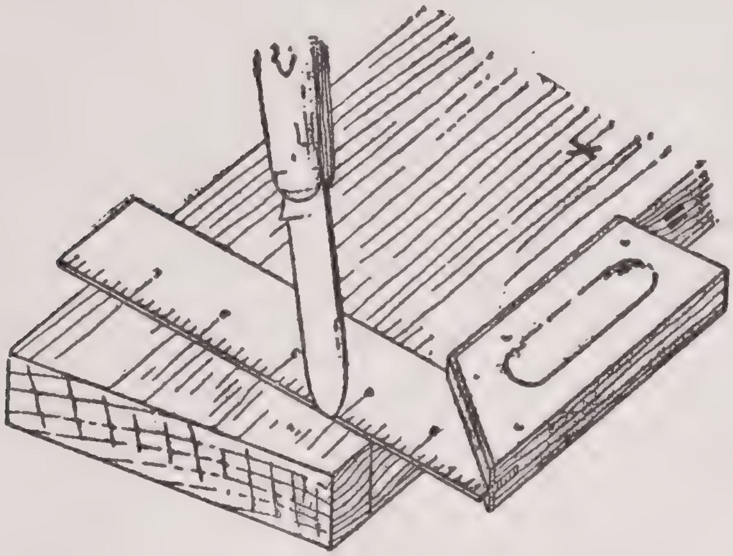


FIG. 67. — Scribing with Knife and Try-square.

When you wish to scribe a line parallel to an edge of a piece of work, the operation is known as

**Gauging.** Figures 68 and 76 show how to gauge with a marking-gauge. Suppose you wish to cut a piece 3 inches wide from a 4-inch board. You must first test one edge and true it up, if necessary, to make it straight for a *working edge* (see *Planing Exercise*), then place the *head* of the gauge against this edge of the board, and with

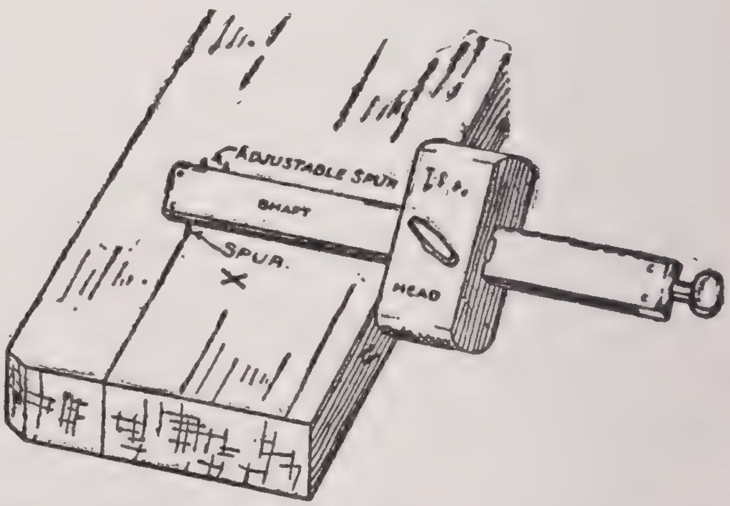



FIG. 68. — Gauging with a Marking-gauge (a Mortise-gauge).

the *spur* in the *shaft* pressed into the surface of the wood (Fig. 68), scratch a line along the board for a distance equal to the length of the piece to be removed; also scribe the line upon the opposite face and you will then have a guide-line upon both faces to saw and plane to, which is exactly parallel to and at a distance of 3 inches from the *working edge*. The gauge is also used for laying out various forms of wood joints. The *double-spur* upon the shaft of the mortise-gauge is provided for laying out the two sides of a *mortise* or *groove* in one operation (Fig. 76), the outer spur being fixed and the inner one made adjustable by means of a thumb-screw in the end of the shaft. This form of gauge saves lots of time, especially when you have a number of mortises or grooves of one size to lay out.

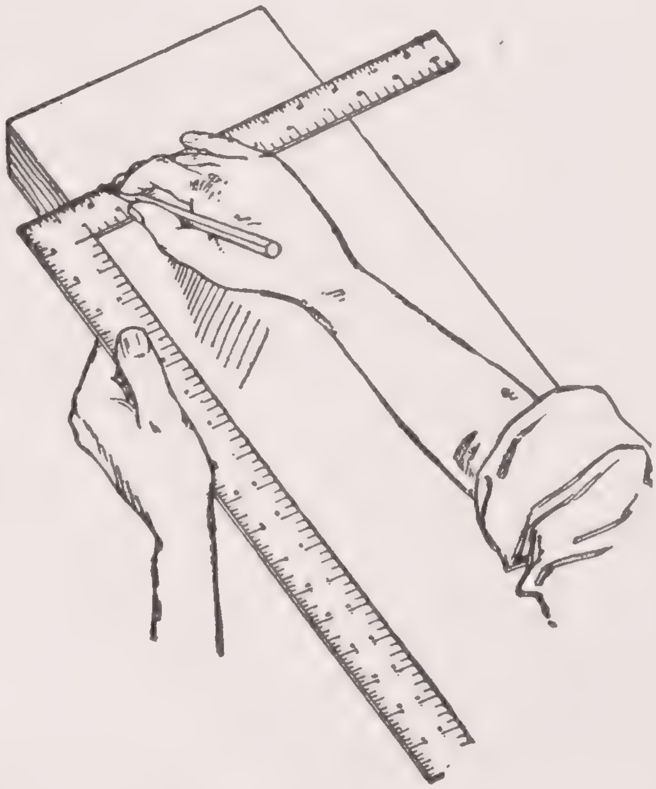


FIG. 69. — Gauging with Pencil and Carpenter's Square.

Figure 69 shows how gauging may be done with a pencil and carpenter's square. Hold the *body* of the square against the edge of the work, with the *tongue* extended across the face upon which the line is to be scribed and the pencil held against the edge at the desired point, and then, with the fingers braced as shown to hold the pen-

cil steady, move the square toward you with your left hand. The same operation may be performed with a try-square and pencil. You will require some practice before you will be able to gauge successfully in this manner, but it is easy when you get the knack of doing it. A rule and pencil may also be used for gauging, as is shown in "The Boy Craftsman."[1] While these methods will answer the purpose for rough work, a marking-gauge is to be preferred for great accuracy.

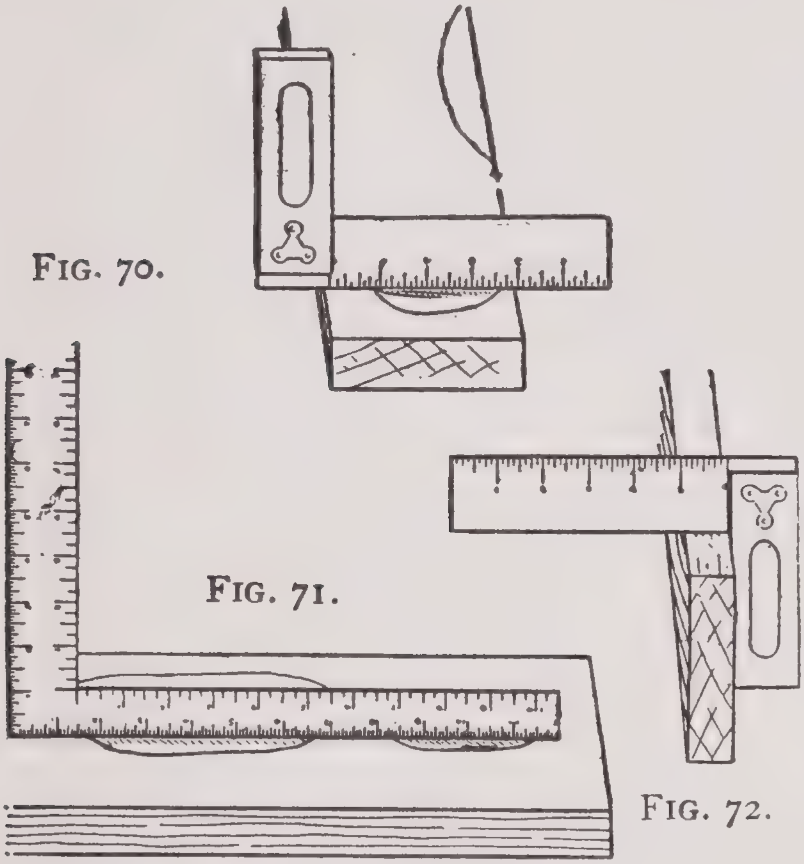


FIG. 70.

FIG. 71.

FIG. 72.

FIG. 70. — Testing with a Try-square.
FIG. 71. — Testing with a Carpenter's Square.
FIG. 72. — Testing an Edge from the Working Face.

**For a Planing Exercise** take a piece of board about 12 inches long. First, test one side, holding the board on a level with your eyes and sighting across it while you move the edge of the try-square along the entire length (Fig. 70). The square will strike the high places and you will be able to distinguish them as the light will show beneath the edge of the square, in the hollows. Locate

[1] Page 43.

the high portions as you pass over them, by drawing a line around them as shown in Fig. 70, so you will know where the places are which require the most planing. Also test the board lengthwise with the carpenter's square (Fig. 71).

A good way to test a board for *winding* (twisting in the length) is by means of

**Winding-sticks** (Fig. 73). Get two pieces of square molding of exactly the same size for the sticks. To make the test, place both sticks across the board, one at the farther end and the other at the near end, and hold the board level and at the proper height to make the tops of the sticks upon a level with your eyes; sight across the sticks, and if their tops appear to be exactly on a line, you may know that there is no *wind* to the board; if one end of one stick appears above the corresponding end of the other stick, you can easily determine where and how much the wind is.

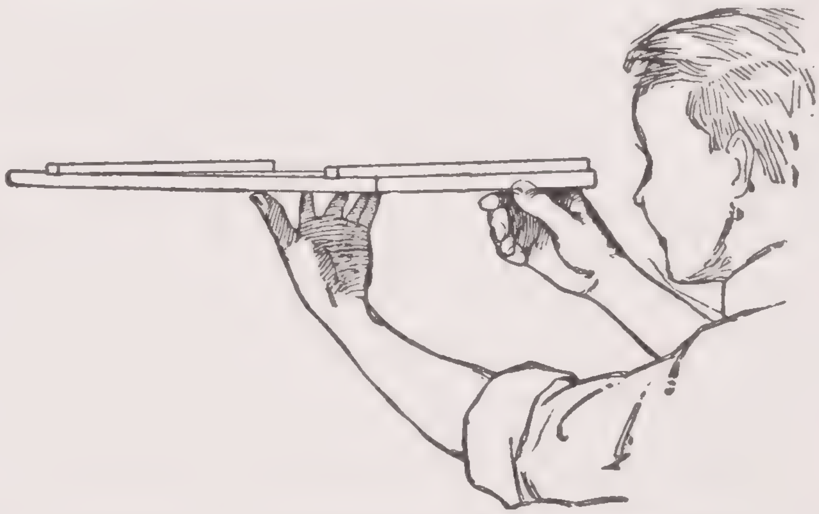


FIG. 73. — Testing with Winding-sticks.

After determining where planing is necessary, place the board in your bench-vise and plane up the face, testing it again and again until you find it to be perfectly true. This first trued surface is called the *working face*

and should be marked with a cross (Fig. 67). With the *handle* of the try-square held firmly against this working face and the *blade* extending across an edge (Fig. 72), move it along the surface, locate the high places, and plane it up and test it as you did the working face. Mark this edge, which now becomes the *working edge*, with two short parallel lines (Fig. 68). Next, set the marking-gauge to any thickness desired for the board and, with the *head* of the gauge pressed firmly against the working face, gauge a line along each edge. Plane up the second face to the gauge lines, test and true up. The ends of the board should be trimmed off next. With the handle of the try-square pressed firmly against the working face, first scribe a line across the working edge, then, with the handle of the square against the working edge, continue this line across the working face and the opposite face. From the working face carry the line across the unfinished edge. Then, from the scribed line, lay off the length to which you wish to cut the piece and scribe another line around the four sides at that distance. Saw off the ends of the board about $\frac{1}{8}$ inch outside of the lines, to allow for planing them up smooth. In planing across *end grain*, the farther edge will split down unless protected. This difficulty may be overcome by placing another piece of wood in front of it when you clamp it in the vise, but it is better to *chamfer* the unfinished edge (see Fig. 90), which is the only reason for not finishing this before the ends. After planing off both ends square, set

the gauge to the width you wish to make the board and gauge a line along the faces and across the ends, sliding the head of the gauge along the working edge (Fig. 68); then saw off the edge to within about $\frac{1}{8}$ inch of the lines with a rip-saw and finish the edge with the plane.

**For a Sawing Exercise**, scribe a series of lines around a trued-up block of wood with your try-square, then place the block in your vise and see how well you can keep to the line while sawing through the block. Stick to this exercise until you can saw the block through exactly on the line, without running off at any point. Guide the saw with your left thumb until it has cut into the wood a little way, hold the saw exactly at right angles to the line, and use long, steady strokes.

No better exercises in laying out work, planing, and sawing can be found than the makingof the

**Joints and Splices** used for joining together pieces of wood, and it is important to practice upon such joinings before attempting to use them upon a nice piece of work, in order that you may not run the risk of spoiling material. Any odd-sized pieces of wood which you have on hand may be used for these exercises as the proportions of the joints may be worked out to suit the size of the piece. The most important joints and splices are shown in Figs. 74 and 75 (pages 58 and 59). By a *joint* is meant any kind of a connection between two pieces placed at an angle to one another, while a *splice* is a connection between two pieces placed in a straight line.

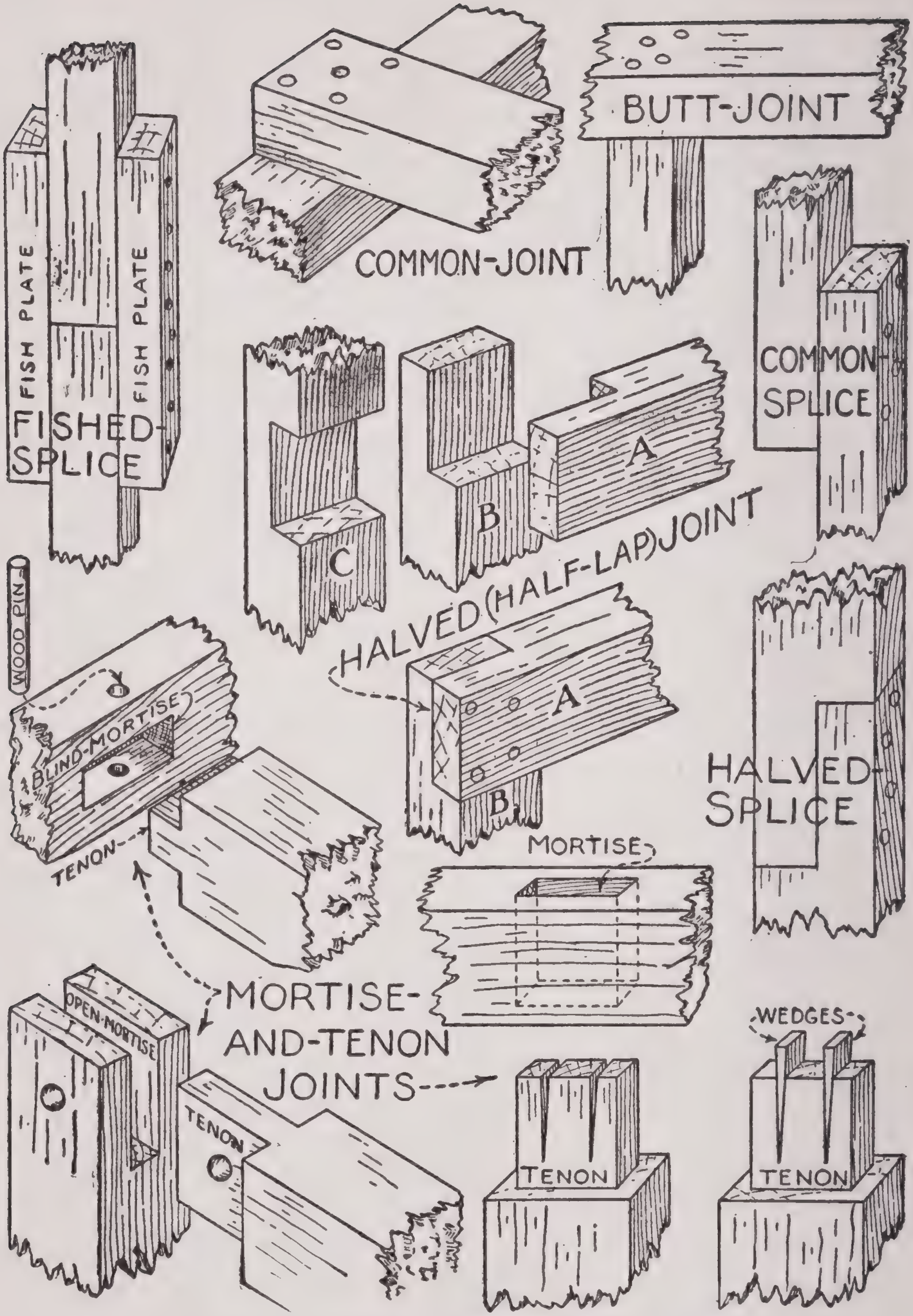



FIG. 74. — Common Forms of Joints and Splices.

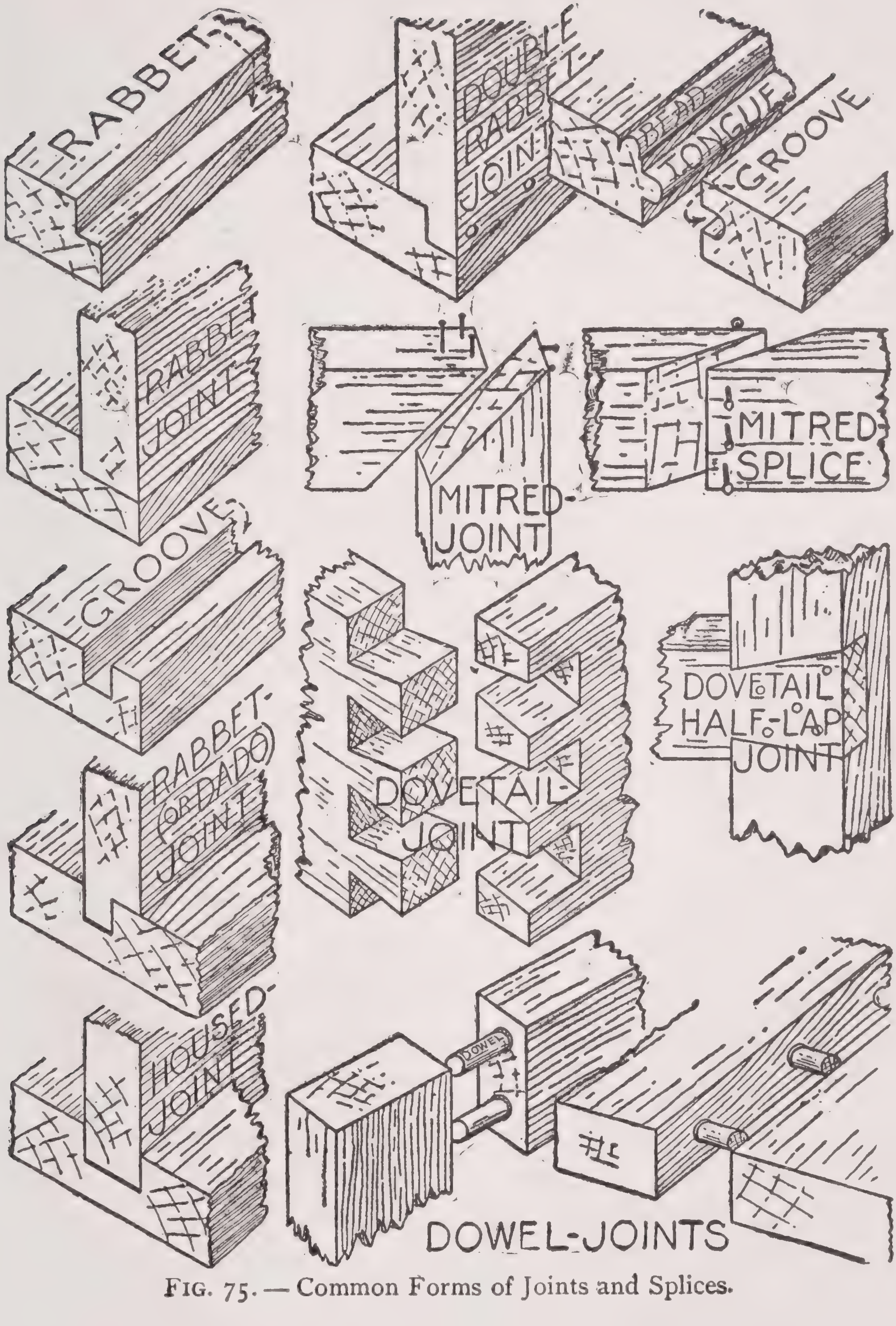



FIG. 75. — Common Forms of Joints and Splices.

You are familiar, of course, with the

**Common-joint and the Butt-joint**, though perhaps you do not know them by name, and no doubt you have used the **Common-splice** and the **Fished-splice** — a better form of splice — in joining together pieces which have been too short in putting up the frameworks for your club-house, tree huts, and other work. You will possibly have to use one of these in constructing the partition for a basement workshop, or an attic room such as is described in Chapter VIII. The above joints and splices are shown clearly in the illustrations and require no explanation.

In the preparation of

**A Halved-joint**, or *Half-lap joint*, as it is sometimes called, a piece equal to the width and one half of the thickness is cut away from each member so the pieces will fit together with their surfaces even or *flush*. The cutting may be done at the ends of the pieces as at *A* and *B*, or away from the end of one piece as at *C*, or in the center of both pieces as shown in Fig. 126 (page 113). Use a square and marking-gauge for laying out the lines for the *halving*. The wood should be removed with a fine saw if the ends of the pieces are *halved*, or with a saw and chisel if the lap is made at the center of the pieces. The *end halved-joint* must be fastened together with nails or screws, but the *center halved-joint* may sometimes be fastened with glue alone.

By joining two pieces lengthwise with a halved-joint

**A Halved-splice** is obtained (Fig. 74).

**The Mortise-and-Tenon Joint** is one of the most important of cabinet-makers' joints, and you will have occasion to employ it in joining together work when it is necessary to make strong connections. Several forms of this joint are shown in Fig. 74, and the method of laying out the *mortise* and the *tenon* is shown in Figs. 76 and 77. Both members of the joint should first be finished up to the proper size, except that additional length must be left on the tenon piece to allow for the cutting of the tenon, and the mortise piece should also be a little longer if the cutting is to be done near the end, to prevent the end from splitting. Ordinarily the mortise should not be more than one third of the width of the piece it is cut through, and the tenon not less then one third of the width of the piece it is cut on, in order that neither piece will be weakened by the cutting.

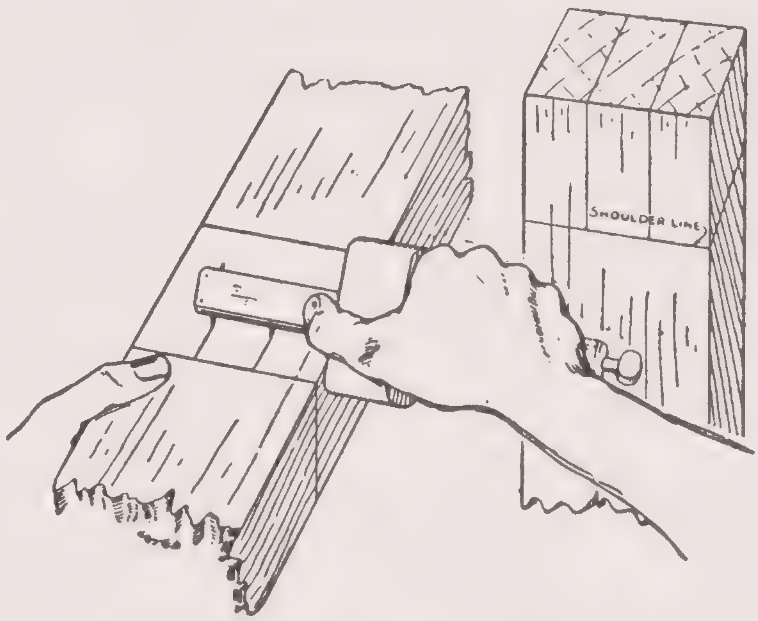



FIG. 76.
Laying out a Mortise with the Mortise-gauge.

FIG. 77.
Tenon Piece laid out ready to be Cut.

I shall explain, first, the making of the mortise-and-tenon joint, in which the mortise is cut entirely through the piece. Lay off the length of the mortise equal to the width of the tenon piece and scribe lines around the four sides of the block to determine the ends

(Fig. 76), then set your mortise-gauge to the width of the mortise and scribe the two side lines (Fig. 76) on both faces of the piece. The width of the mortise should be made the exact width of one of your chisels, if possible, so that the cutting of the entire width may be done in one operation (Figs. 78 and 79); this will leave little or no trimming to do on the sides.

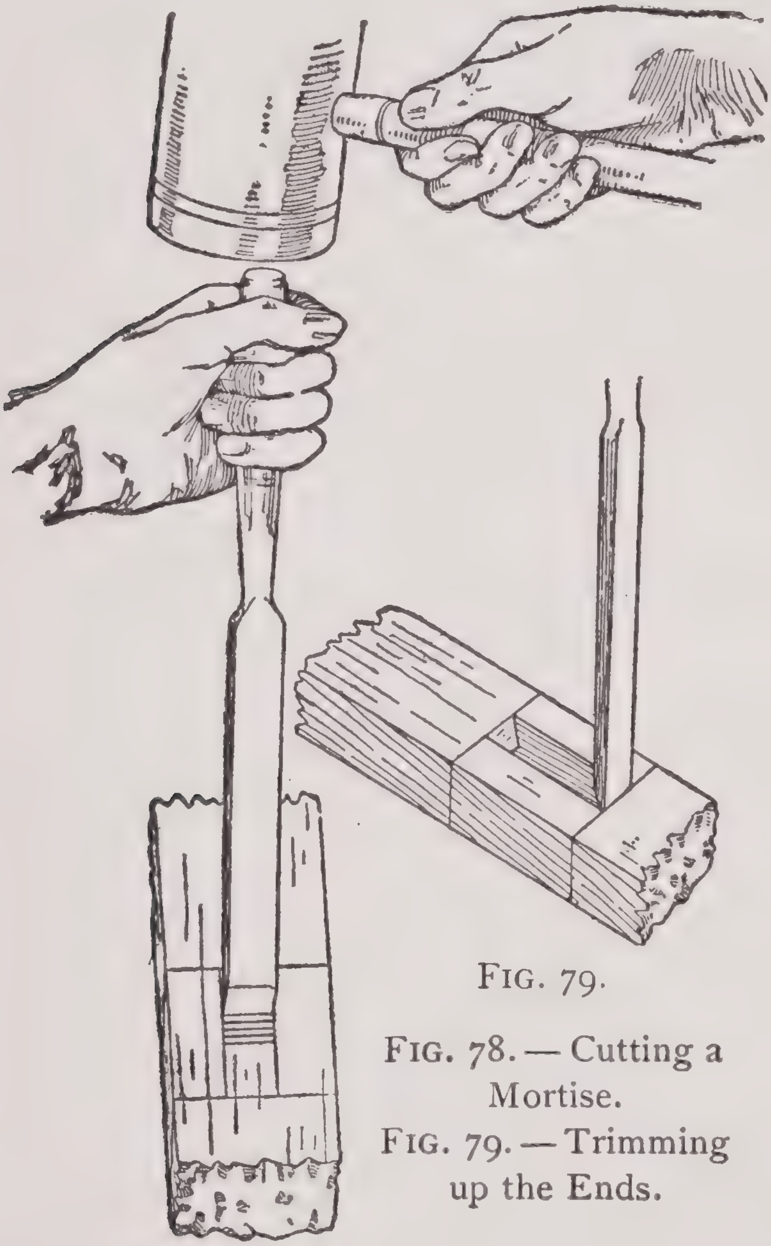


Fig. 79.

Fig. 78. — Cutting a Mortise.
Fig. 79. — Trimming up the Ends.

Fig. 78.

To cut the mortise, place the piece of work upon the bench with one end toward you, then with the chisel held as shown in Fig. 78, with the beveled side facing you, start at the middle of the space marked out and drive the chisel into the wood, then withdraw the chisel, set its edge about $\frac{1}{8}$ inch back of this first cut and drive it into the wood again; continue cutting in this manner, now and then prying out the pieces between the cuts

until the farther guide-line has been reached, then reverse the position of the piece of work and, starting at the center again, cut from there back to the other end of the space. The mortise should be cut through one half the thickness of the piece, then the piece should be turned over and the remaining one half cut through from that face. The ends of the mortise must then be trimmed up, and for this part of the work the flat side of the chisel must be held toward the line as in Fig. 79. This trimming, or *paring*, should be done without the use of a mallet. A mortise is very often made by boring a number of holes and then trimming up to the guide-line with a chisel, in the same manner as is described for cutting large, round holes on page 142 (see Fig. 156).

Lay off the length of the tenon with enough allowance for trimming the end later, then scribe a line around the four sides of the piece to locate the *shoulder* of the tenon (Fig. 77). Set the spurs of the mortise-gauge a trifle farther apart than the width of the mortise, to allow for the thickness of the saw in cutting, and scribe the side lines of the tenon from the shoulder line to the end, across the end, and down the other side to the shoulder line. With a back-saw cut the shoulders along the shoulder line, being very careful to saw exactly on the line, then place the piece in the bench-vise as shown in Fig. 80 and cut down the sides of the tenon to the shoulder. The tenon should fit fairly tight in the mortise, but not so tight that it will not drive easily when coated with glue. If a

little too large for the mortise, trim the tenon with a chisel. Short tenons may be cut entirely with the chisel. After fitting the pieces together, trim off the end of the tenon flush with the face of the mortise. One of the tenon pieces shown in the illustration has a shoulder cut upon all four sides, which is commonly done to conceal the edges of the mortise, while one of the mortises is shown cut but part way through the piece (a *blind* mortise); the tenon for the latter mortise must be made $\frac{1}{8}$ inch shorter than the depth of the mortise to allow plenty of clearance for the end. The *open mortise-and-tenon joint* illustrated is a common form and simpler to make than the *closed* joint, as the mortise may be cut with a saw and chisel.

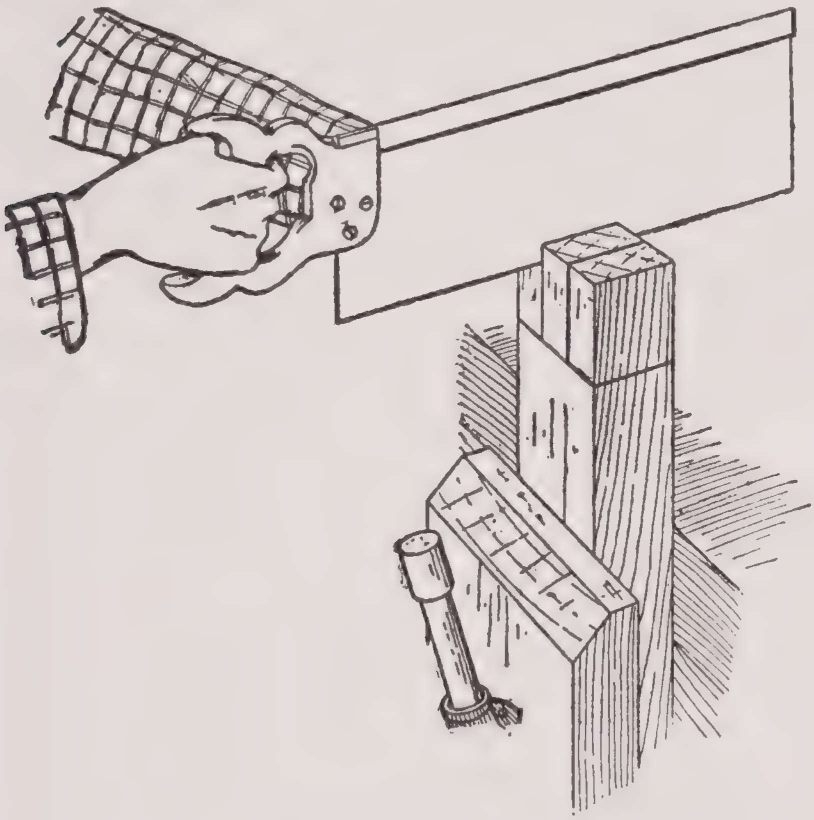


FIG. 80. — Cutting the Sides of a Tenon.

In making the furniture detailed in Chapter VI you will use the full-depth mortise only on pieces through which the tenon projects, and for *pins*, as you will see by looking at the working-drawings, the blind mortise being made in all other cases.

Tenons may be fastened in place with *glue*, *nails*, *screws*, *pins*, or *wedges*. For gluing see page 72, for nailing see page 74, and for screwing see page 72. The form of

**Pins** which you will use most are those described for the construction of the furniture in Chapter VI. In Fig. 74 you will see another common way of pinning together the members of a mortise-and-tenon joint. First of all, a small hole is bored through the sides of the mortise, then the tenon is slipped into place and the position of the hole marked upon it, and then the hole is bored through the tenon about $\frac{1}{16}$ inch nearer to the shoulder than where located. By changing the position of the hole you will see that the pin will draw the shoulder on the tenon piece tight against the mortise piece, when driven into place. For

**Wedging** the tenon (Fig. 74), one or more *kerfs* are sawed in the end of the tenon, and after the tenon has been slipped through the mortise, wood wedges are coated with glue and driven into the kerfs, thus spreading the end of the tenon in the same way in which the handle of a hammer is fastened in the head.

**A Rabbet** is a square-corner *groove* cut in the edge of a board (Fig. 75), and

**A Rabbet-joint** may be made by fitting a square-edge piece into a *rabbeted* piece, by fitting together two pieces with rabbeted edges, and by fitting a rabbeted piece into a *grooved* piece. A rabbet may be cut with a chisel after

the manner described for cutting a mortise (Fig. 78), or if it extends along the full length of a short piece, it may be cut with a saw; but if you have much rabbeting to do, it will be well to have a *rabbet-plane* (Fig. 22) for the purpose, or have your work done on a circular saw.

**Grooves** may be cut with a chisel in the same way that mortises are cut, but this work is also simplified by using a *dado-plane* (Fig. 23).

The similarity between a rabbet-joint and

**A Housed-joint** often causes a confusion of the two. But there is no rabbeting in the housed-joint, the entire edge of one piece being fitted, or *housed*, into a groove cut in the other; so if you will remember this, you will have no trouble in distinguishing one from the other.

**The Tongue-and-Groove Joint** is one which you will probably never have occasion to make, and if you ever do, it will be best to take your work to a mill and have it done by machines especially made for the purpose. You will, however, have need of tongued-and-grooved boards for work requiring tight joints, and these, of course, are stock stuff.

**The Mitered-joint** will be used a great deal in making picture-frames and other cabinet work. It is always a 45-degree cut and should be made in a miter-box (Fig. 59, page 39) to insure accuracy. The illustrations show

**A Mitered-splice**, or *beveled-lap splice*, used a good deal in splicing long stretches of interior woodwork.

**The Dovetail-joint** is a joint you will never need to

apply to your work, in all probability, but a great degree of accuracy is required in making it to secure a neat job, and for this reason it furnishes a splendid exercise for a beginner. The dovetail in modified forms is used in the manufacture of small boxes, and in the joining of the front and sides of drawers, in which case it is all done by a machine.

Figures 81 to 84 show the necessary steps for dovetailing the ends of two pieces by hand. First, plane up the pieces true and to the same width and thickness, then taking the piece upon which the dovetail mortises are to be cut (Fig. 81), scribe the line *AB* around the two faces and edges at a distance from the end equal to the exact thickness of the tenon piece. Lay off spaces of $\frac{3}{8}$ inch and $\frac{5}{8}$ inch, alternately, upon this line and scribe lines parallel to the edges of the piece from these points to the end, around the end. and back to line *AB* on the other face. Next, lay off the oblique side lines of the mortises on both faces, then place the piece in the bench-vise, end up, and saw down along these lines as far as line *AB*, using a fine saw for the purpose, after which cut out the wood between, marked *M*, with a chisel (Fig. 82). Place

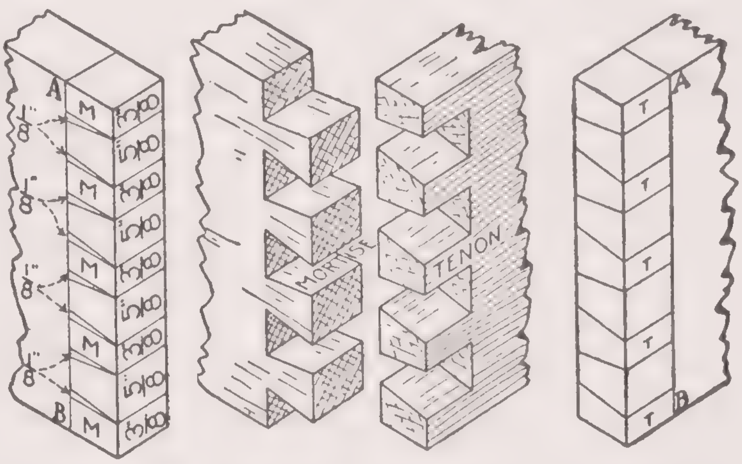



FIG. 81. FIG. 82. FIG. 84. FIG. 83.
FIGS. 81–84. — Details of the Dovetail-joint.

the finished mortise piece upon the end of the tenon piece and mark off the tenons, then, to allow for cutting, move the lines over about $\frac{1}{16}$ inch each side of the tenons and, after this has been done, scribe their ends across to line *AB*, which should be scribed around this piece at a distance from the end equal to the thickness of the mortise piece (Fig. 83). The last step consists in sawing down along the side lines of the tenons and cutting out the wood between, marked *T* (Fig. 84).

**A Dovetail Half-lap Joint** (Fig. 75) has the advantage over an ordinary half-lap joint of so locking the pieces that it is impossible to pull it apart, lengthwise of the pieces, without breaking the tenon.

**The Dowel-joint** (Fig. 75) is a *butt-joint*, but the members are fastened together with wooden pins called *dowels*. The form at the left lacks the strength and neatness of a mortise-and-tenon joint, but is often used in cheap work. At the right is shown how two or more boards may be *doweled* together to form a wide piece. *Dowel sticks* of all diameters are made for *doweling*, and you can get what you need at any hardware store, which will be more satisfactory than to cut them out yourself. The boring of the holes in the proper positions and at right angles to the edges, so the pieces will fit together *flush* and *flat*, requires some practice. After you have *jointed* the edges of the pieces (see page 40), set your marking-gauge to a measurement equal to one half their thickness, and, from the *working face* of each board, gauge a line

along the entire length of the edge for a center-line. Then place the boards back to back in your bench-vise, with the edges even, locate the centers of the holes along one center-line and scribe lines from these points across to the other center-line. If the boards are perfectly straight and the holes are bored carefully, the dowels will bring the pieces together exactly right, but in case you find they do not fit, it is easy enough to adjust the trouble by boring extra pairs of holes at the points where the boards are out of line, shifting the centers just as much as is necessary. Bevel the edges of the holes with a knife or a *countersink* to form pockets around the dowels for glue. To allow plenty of clearance, cut the dowels about $\frac{1}{4}$ inch shorter than the combined depths of the holes, then, after you have found that the boards fit together perfectly, coat one half of the length of the dowels with glue and stick them into the holes in one of the edges. Allow the glue to *set*, then coat the edge of each board and the other half of each dowel with glue, put the pieces together and clamp them tightly. Allow the glue to set for about a day before releasing the work.

**Battens** are strips fastened across two or more pieces of wood for the purpose of holding them together (*A*, Fig. 44, page 32), while

**Cleats** are strips often used for the same purpose, but generally so secured that the pieces will have a chance to *swell* and *shrink*. It is well enough to nail battens

across boards in rough work where it is not important whether the joints remain closed or not, but it will not do for cabinet work. All woodwork expands and contracts to a certain extent with changes in the temperature, and when battens are securely fastened across glued-up work they do not check this movement, nor do the nails or screws *give* enough to take care of it, so the only other thing possible takes place — the wood breaks away from the fastenings and possibly splits from end to end. Figure 85 shows how the movement may be taken care of by attaching cleats to the work. These cleats are held in place with screws, but the screw holes are bored about twice the size of the screws, and washers large enough to cover the holes are used to support the screw-heads. By placing the screws in the exact center of the holes, the ends are free to work back and forth with the movement of the wood. Cleats are attached to the back of single boards and glued-up work in the same way, to prevent warping, and sometimes they are grooved on to the ends of work. A strip fastened up for a shelf or drawer support is also known as a cleat.

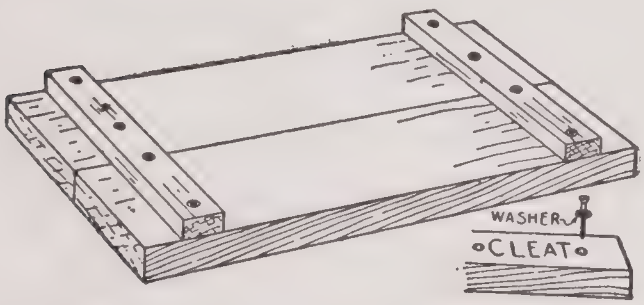


FIG. 85. — The Proper Way to cleat Boards.

You have now learned the difference between a *rabbet*, *groove*, *bead*, *mortise*, *tongue*, *tenon*, *dovetail*, and *miter*, used in making joints and splices, but there are several

other *cuts* which you should know. When you read about the

**Taper** on a piece of work, you must understand this to refer to a gradual decrease in the thickness of the material, forming a slanted surface or edge (Fig. 86). Then there is the

**Bevel**, a flat surface cut obliquely to its adjoining surfaces (Fig. 87), and a

**Chamfer**, three forms of which are shown in Figs. 88, 89, and 90. The *bevel* and the *chamfer bevel* are similar, but the latter is usually used only on end grain for the purpose of preventing the wood from splitting down when planing against it. Use a marking-gauge with which to lay out these cuts, and make the bevel and the chamfer bevel with a plane or chisel, the *stop chamfer* with a chisel or spoke-shave, and the *chamfer groove* with a gouge.

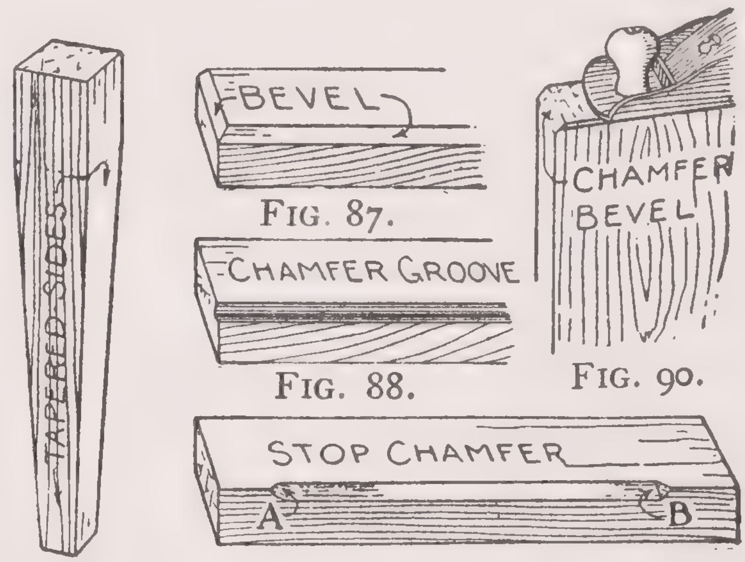



FIG. 86. FIG. 87. FIG. 88. FIG. 89. FIG. 90.

FIG. 86. — Tapered Surface.
FIG. 87. — Bevel.
FIGS. 88–90. — Three Forms of Chamfers.

Woodwork is usually fastened together by means of *glue*, *pins*, *dowels*, *wedges*, *screws*, *nails*, or *bolts*. The use of pins, dowels, and wedges has been discussed. The best glue for you to use for

**Gluing up Work** is the liquid glue sold in small bottles and cans. For work that may be exposed to moisture, use

**Casein Glue,** a waterproof glue of great strength. Casein glue comes in powdered form, and you mix it with cold water in equal parts.

**Ambroid Cement** and similar quick-setting adhesives are better for model airplane construction and other small model building. They are strong and light in weight.

Use a brush to apply glue, a match to apply cement.

Before gluing any work, fit every part together and make sure that no further trimming of the joints is necessary; then wipe the portions to be glued with a cloth to remove all sawdust, and apply the glue thoroughly, but not too thick, to one part at a time. After the pieces have been glued in place, unless the joints are mortise-and-tenon joints or other joints which will drive together, the work must be held by *handscrews* (Fig. 40, page 29), *cabinet-maker's clamps* (Fig. 41), or *home-made clamps* (Fig. 42), until the glue has thoroughly *set*, for which about a day's time should be allowed. All surplus glue which has oozed out of joints should be scraped off and the surface sandpapered clean and smooth before any *finish* is applied.

**Screws** will hold work together better than nails, in places where the latter cannot be *clinched*, and are to be preferred wherever it is possible to use them. The principal forms of wood-screws are the *flat-head*, the *round-head* or *finishing-screw*, and the *square-head* or *lag-screw.*

The last form is used for large, rough work, the heads being made like bolt-heads so they may be turned with a wrench.

In fastening together two pieces of hard wood, or very thin wood, it is necessary to drill holes for the screws before driving them, in the first case to make the driving easier, and in the second case to prevent the wood from splitting. The hole in the upper piece should be made a trifle larger than the diameter of the stem of the screw, so the screw will slip through it without binding, while the hole in the lower piece must of course be enough smaller than the screw so it will thread its way into the wood and take a good hold. In some cases it is necessary to bore the hole in the upper piece a good deal larger than the stem, as in the case of *cleating* (see *Cleats*, page 69). In rough work, or in unexposed places, the screw-heads may be driven in flush with the surface, but on particular work the heads must be *countersunk* (driven below the surface) far enough so the heads may be concealed with putty and whatever finish is placed upon the wood. Countersinking is done with the *countersink* (Fig. 16, page 16), which bevels off the top edge of the screw hole enough to allow the head to drop below the surface. Screws will *drive* into hard wood easier if soaped, that is, rubbed over a piece of soap until the threads are coated. This also prevents the possibility of slender screws twisting off, which they are likely to do when forced very hard.

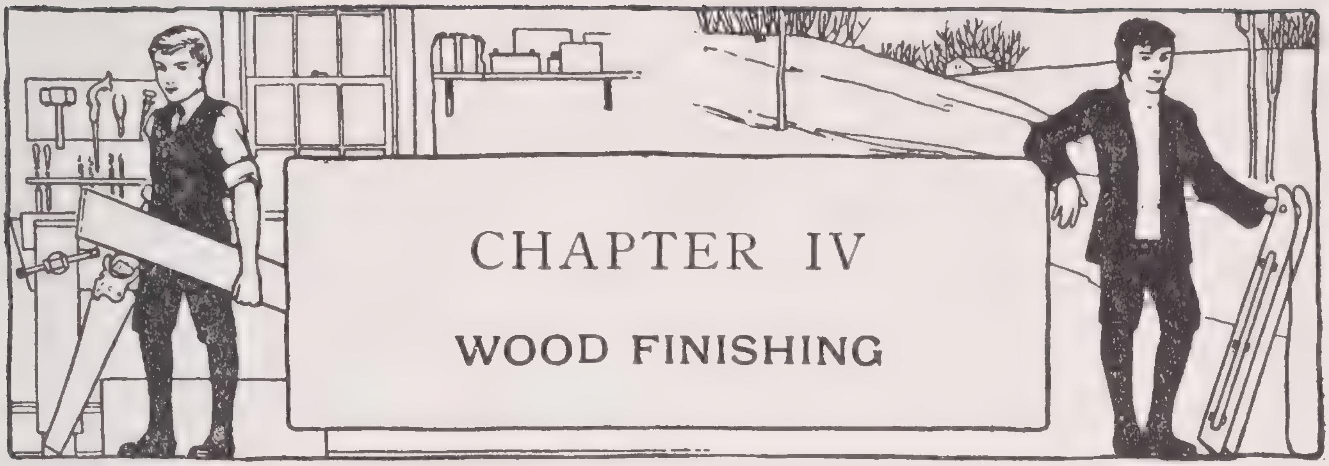
**Nails** are made of wrought-iron, wire (bright and galvanized), brass, and copper. Of these you will seldom use others than the *common wire nail* for rough work, the *brad* and *finishing-nail* for work where it is necessary to drive the heads below the surface of the wood, and in so doing to make as small a hole as possible, and *copper* or *galvanized wire nails* for boat building and other outside work where nails are exposed to rust.

Holes should always be started in very thin wood to prevent splitting, and it is necessary to do the same in hard wood to prevent the nails from bending. The holes must be a trifle smaller than the nails and may be made with a brad-awl (Fig. 16, page 16), or a small drill (Fig. 26, page 23). In all work but of the roughest kind, the nail-heads should be *set* low enough so they may be concealed with putty before the wood is finished. The setting is done by means of a *nail-set* (Fig. 16, page 16).

**Corrugated Fasteners** reinforce joints between surfaces.

**Carriage-bolts** are used more or less frequently in carpentry in order to pivot one piece to another, or to hold several pieces together (generally in large work) where they are likely to be subjected to a strain that nails or screws would not stand. You will use these as *king-bolts* in making your bob-sleds (Chap. XVIII) and your wagons (Chap. XXIV), and for securing in place the *rowlock blocks* of your boats (Chaps. XXII and XXIII).

**Stove Bolts** also are required for joining parts.



# CHAPTER IV

## WOOD FINISHING

THE finishing of work is equally as important as the constructive part because the final appearance of the article depends upon the care with which it is done. Many a well-made piece of furniture has been ruined by poor taste in the selection of finish, or as a result of carelessness or inexperience on the part of the amateur craftsman applying it. With practice, however, any boy can master the common forms of finishes—*painting*, *enamelling*, *staining*, *shellacking*, *waxing*, *varnishing*, and *oiling*, so he can turn out a satisfactory job.

The kind of finish to be selected for a piece of work depends, of course, upon the variety of wood used, the nature of the article, and the wear to which it will be subjected. For your sleds, wagons, boats, club-houses, and most of your home-made outdoor equipment, as well as much of that made for indoors,

**Paint** is the most suitable finish. Ready-mixed paints may be obtained in various colors, and this is probably the most satisfactory way for a boy to purchase paint if he wants a large quantity, but for small work

where only a small amount of one color is required it is best to buy the *lead ground in oil*, of the color desired, and thin down with turpentine as much as is needed for the job; paint may be bought in this form in 1-pound cans. The balance of the paint in the can may be kept soft by pouring in enough water or linseed-oil to cover the surface; this may be poured off again when you wish to use more paint.

As most of you boys probably know, the combination of red and yellow makes orange, yellow and blue makes green, blue and red makes purple, green and red makes brown, and black and white makes gray. Different shades may be obtained by using a larger proportion of one or the other color, and black and white will darken or lighten the color. By purchasing *Venetian red*, *chrome-yellow*, *Prussian blue*, *lampblack*, and *white lead* (or *zinc-white*), you will be able to mix up almost every shade of any color you wish to use, but you will probably find in *burnt umber* or *burnt sienna* just the shade of brown you want, and in *chrome-green* or *olive-green* the right shade of green, in which case it will pay you to buy a can of each.

**In Mixing Paints**, mix up at one time as much as will be necessary to complete a job, as it is usually difficult to match a color exactly, and a slight change in the shade will spoil the appearance of the work you are finishing. Try the color upon a piece of wood of the same kind as that of the article to be painted, before you go ahead with

the painting, and allow it to dry so you can see whether or not it is going to look right.

**Brushes.** Figure 91 shows a number of brushes which will generally answer every purpose of the amateur. The two large brushes will be needed for general painting, the two sash-tools for small work and for getting into corners, and the smallest brush for striping, marking, and lettering. Then there is the medium-sized varnish brush which must be used only for varnishing and shellacking, and the glue brush mentioned in Chapter III. When you are through painting, staining, or varnishing, wash out your brushes in turpentine, or if you expect to use them in the same material within a day or so you may place them in water, which will keep the paint from hardening without injuring the bristles if the brushes are prevented from resting upon the bottom of the receptacle. To support the brushes, bore holes through the handles in the proper places so that when run upon a piece of wire and the wire is laid across the rim of the can or other receptacle, the ends of the bristles will not touch the bottom.

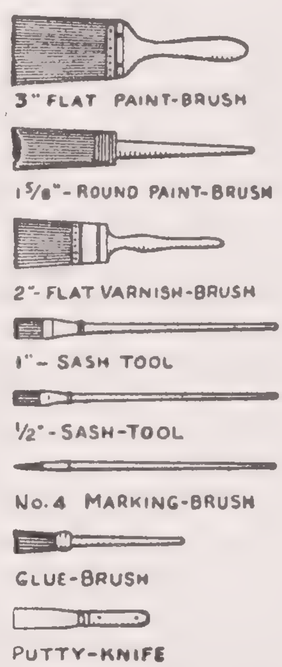



FIG. 91. Brushes and Putty-knife.

**In Painting** wipe off your brush upon the edge of the paint can after dipping it into the paint, so it will not drip and spatter over everything. Apply the paint thinly and always start at one end of a surface and work

toward the other. If there are any *resinous* knots in the wood, first give them a coat of shellac to *set* the resin so there will be no danger of oozing through the surface after it has been painted. The first coat is known as the *priming coat.* After it has dried, the work should be gone over carefully and all nail holes, and cracks and other defects puttied up (see *Puttying*, page 84). After puttying, sandpaper all rough places (see *Sandpapering*, page 84) before applying a second coat. Two coats will be sufficient for ordinary work.

**Enamels** contain varnish, and are prepared in satin and glossy finishes. You can buy them in quarter-pint cans and larger sizes, in various shades of all colors. The small cans are the best size for small jobs. With red, yellow, blue, black, and white, you can mix almost any shade of color that you need.

An enamel job requires filled surfaces, if the wood is of open grain, and a coat of shellac or flat paint for an under coat. One or two coats of enamel will be sufficient over an under coat. But, omitting the shellac or flat paint, an extra coat of enamel will be necessary. Rub the surfaces lightly with fine sandpaper after all but the final coat. Flow the enamel on with a fine varnish brush (Fig. 91), following the directions on the can label for applying. Fast-drying enamels dry hard in about four hours.

**Lacquers** are difficult to handle upon large surfaces without showing laps, if applied with a brush, because

of their fast-drying properties. They should be sprayed on with a spray gun. You can buy spray guns that are operated by hand, and by motors. Indeed, there are several makes that connect with the reverse end of a vacuum cleaner. It is easy to spray lacquer evenly with a gun. You would have no difficulty with a brush lacquer job on small surfaces, but you will probably find fast drying enamels more to your liking.

Lacquers cannot be applied over varnished surfaces. Lacquer brushes must be cleaned with lacquer thinner.

**Water Stains** roughen the grain of wood, making it necessary to sandpaper the surface after an application has dried, but they have an advantage over the oil stains in the fact that they bring out more strongly the lines of the grain, the oil stains being less transparent and concealing, somewhat, the delicate lines and pores. But for the fine-grained woods, oil stains are easier to apply.

**Oil Stains** are easy to mix, and the author advises his readers to do some experimenting along this line. With the colors mentioned under *Paint*, any of the standard shades of green, gray, and brown may be made. The prepared stains are accompanied with full instructions for application. Before using your home-made stain, sandpaper the surface of your work thoroughly, then apply the stain with a brush or piece of cloth, and rub it in vigorously with a piece of soft muslin or cheesecloth. Allow the work to dry for a day, then go over it and fill up all nail holes with putty colored with the stain;

clean off the putty crumbs and apply a second coat of the stain. The surface may be left without further treatment, but it is advisable to put a coat of *white shellac* over the oil, and when this has dried to wax it, in order to produce a hard finish. Unless you protect the surface in some such way, it will become spotted, as the oil in the stain never entirely dries, and rubs off.

Some very pleasing effects upon oak have been obtained by the author by applying the two coats of stain in two different colors, instead of mixing them together and putting them on as one color. For instance, to produce a green finish, a thin coat of Venetian red was first rubbed well into the grain, then on top of this a coat of chrome-green was applied (chrome-green may be made by mixing together chrome-yellow and Prussian blue, if you do not wish to buy a can of it). The result was a pretty green with just a slight suggestion of a reddish tinge to the grain. The *Drafting Table* and *Bench* shown in the photograph opposite page 86 were finished in this way. By applying a thinner coat of the green than of the red, and wiping it off a little more, a pretty dark brown having a tinge of red showing through it may be obtained. The only difficulty an amateur will experience in putting on a stain in this manner will be in using the same amount of stain upon the work that he has used upon his sample, and in rubbing it down to the same tone; but with a little experience he will be able to obtain excellent results.

*White shellac* must be used for

**Shellacking** stained woodwork, as the commoner kind —*orange shellac*—will alter the tone of the stain and probably ruin the work. It is better to buy the white shellac already prepared. Use a 2-inch varnish brush such as is shown in Fig. 91, and if the shellac is thick, dilute it with alcohol just before using it, as it must be thin enough to flow freely over the work. Start at one end of the surface to be covered and work toward the other end, using long, even strokes and being careful not to skip any places and not to go over the same part of the surface twice; uncovered portions and *laps* will show through the finish and give it an uneven appearance.

Shellac alone makes a splendid finish for articles made of soft wood,—such as kitchen and pantry conveniences, etc.,—and is quickly put on. The orange shellac is better than the white for this purpose, as it gives the wood a richer tone. You can buy the orange shellac chips and *cut* (dissolve) them by placing them in a glass preserve-jar, or empty varnish can, and covering them with wood alcohol. Dilute the shellac with alcohol as much as is necessary to make it thin, when you are ready to use it. Three coats of shellac are sufficient for an ordinary piece of work. Allow each coat to dry for at least a day before applying another, and sandpaper the surface after each coat has dried, to remove all roughness. After the final coat, instead of sandpapering it, a

better finish may be obtained by rubbing the surface with a piece of flannel, or other soft cloth, dipped in powdered pumice-stone moistened with linseed-oil. Besides smoothing the surface, this rubbing *cuts* the gloss and produces an even, soft tone. All nail holes should be puttied up after the first coat has dried.

**Filling** is necessary in preparing a surface for varnishing, to fill out the grain and make a smooth, level surface, especially on wood having a coarse grain, such as oak. Factory furniture, finished in Flemish-oak, weathered-oak, or any of the other modern stain finishes, is filled after the staining has been done; but you will secure richer effects by omitting this from such work, as it conceals much of the beauty of the grain, especially in the open-grained woods.

Filling is best done by the amateur with a

**Paste Filler**, which can be purchased at any paint store. The filler must be thinned with turpentine to the consistency of cream and then be spread evenly over the wood with a brush or cloth, allowed to *set* for ten or fifteen minutes, and then rubbed off across the grain so as to fill all of the pores; do the rubbing with excelsior or a piece of burlap. The filler must be allowed to dry for about twelve hours before the shellacking is done. Filler may be bought in the *natural* and colored to suit the finish to be applied to the wood, or it may be obtained already prepared in the color of one of a number of standard wood finishes.

**Waxing** gives a stained surface a much richer tone than varnish, and is easier to apply. Prepared wax can be purchased at a paint store. It should be rubbed on with a cloth, allowed to stand ten or fifteen minutes, and then rubbed vigorously with a soft cloth until a polish is obtained. Waxed surfaces must not come in contact with water, for they will become spotted if they do and require rewaxing.

**Varnishing** is seldom done nowadays by amateur craftsmen in finishing woodwork, but it is necessary as a protection upon surfaces which are subjected to water, so a few pointers are given here. If the wood has an *open* grain, it must first be filled, then given a coat of shellac to form a body for the varnish. Flow the varnish over the surface with a varnish brush such as is shown in Fig. 91, then brush it crosswise of the grain and finish by brushing it lengthwise of the grain. One coat will be sufficient for all ordinary work, but two coats will produce a finer finish. Several days' time should be allowed to elapse between coats. The glossy surface may be cut by

**Rubbing** it down with a soft cloth dipped in powdered pumice-stone wet with linseed-oil or water. After the surface has been rubbed and the pumice-stone thoroughly cleaned off, it may be improved by

**Polishing** with *rottenstone* and linseed-oil, rubbed on with a piece of cotton-flannel.

In buying varnish it pays to get a good grade, as its

better wearing qualities will make it cheaper in the long run than the low-priced varnishes, which are usually very unsatisfactory.

**Oiling** the surface of a piece of work accentuates the markings of the grain and gives to the wood a beautiful rich tone. This is an especially good finish for articles made out of cigar boxes (see Chap. XI). Apply the oil with a brush or rag, then rub it vigorously with a soft cloth, until you have worked into the grain as much as it will take, and wipe off the superfluous oil.

**Sandpapering.** You will have occasion to use about four grades of sandpaper — No. 1½ for coarse work, Nos. ½ and 0 for medium work, and Nos. 0 and 00 for fine work. Nos. 0 and 00 are of the proper degree of fineness for sandpapering painted, stained, and shellacked surfaces. To avoid scratching a surface always sandpaper length-wise of the grain. For sandpapering flat surfaces, the paper should be attached to a block of wood. (On page 11 of "The Boy Craftsman" is shown a specially formed block for this purpose.)

**Puttying.** Putty can be purchased at the paint stores now in sealed one-pound cans, at about five cents a can. A small quantity will go a long way, and it is best to buy a small amount at a time, as it hardens very quickly when exposed to the air. Putty may be kept soft, however, by placing it in a can of water.

Before using putty, knead it in your hand to *work* back into it the oil which rises to the surface, and if the article

upon which it is to be used is stained, work enough of the stain into it to make it of the right color. It is always best to putty after the priming coat has been applied, in painting, and after the first coat of stain has been put on, in oil staining, as the oil soaks into the holes and cracks and the putty sticks better as a result.

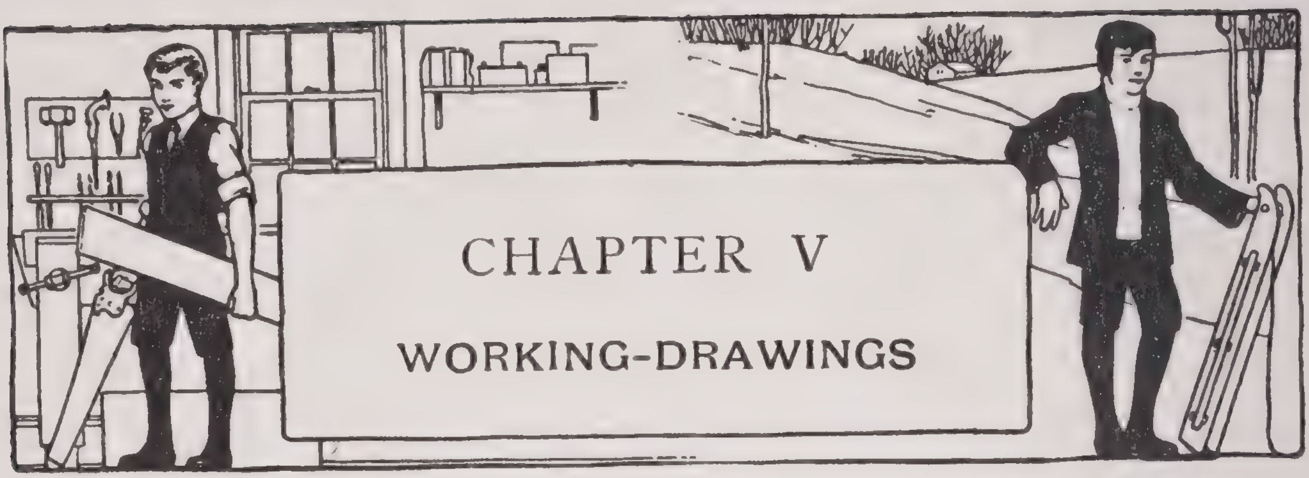
Painters use a putty-knife (Fig. 91) with which to press putty into the crevices of work, but you can use the blade of your jack-knife for the purpose, or a fairly good

**Home-made Putty-knife** may be obtained by cutting off square the end of a five-cent potato knife.

As a final word upon the subject of wood finishing, the author wishes to caution you boys to

**Be Careful of Oily Rags** and waste and not allow them to lie around, for they are very likely to catch fire through *spontaneous combustion*. Burn up everything of this nature as soon as you are through with it.

**Crack-fillers** are preferable to putty for some purposes. One kind comes in plastic form that hardens after a short exposure to air, and forms a surface as hard as wood, that can be cut, carved, nailed into, and finished the same as wood. This plastic filler can be used for building up surfaces and molding ornamental portions of models, as well as for puttying nail-holes, cracks, and defects. Another crack-filler comes in powdered form, and is prepared for use by mixing into a thick paste with cold water. It, too, can be worked and finished the same as wood, when it has hardened.



# CHAPTER V

## WORKING-DRAWINGS

By a working-drawing is meant a mechanical representation of an object, either drawn accurately to measurements or laid out roughly with dimensions marked upon it, with which a mechanic can get to work and make the entire object complete. Sometimes, every part of the work can be so shown upon a single sheet that no other word of explanation is required by the mechanic; again, on more complicated work, general working-drawings showing the main portions of the structure or machine must be prepared, and then all the minor parts taken up singly and worked out (*detailed*) on other sheets, forming what are known as *detail drawings*. In very complex work hundreds of these drawings are often necessary in order that the *designer* or *draftsman* may make certain that every part of the construction will work out properly and that the workmen will understand his intentions, and in many kinds of work it is necessary to furnish in addition to all these details printed or typewritten instructions, known as *specifications*, to explain the kinds, grades, and sizes of materials, and complicated

portions which cannot be covered by notes upon the drawings.

The average person usually has difficulty in reading a working-drawing, for the fact that he looks at it as he does a picture, expecting to see everything standing out in a photographic form. And until the beginner understands what a *plan*, *elevation*, and *section* are he will continue to have this difficulty. To make the explanation as simple as possible, the working-drawings for a dog-house are shown in Fig. 92. The *plan* shows a view of the floor of the house as you would see it if you sawed through the walls and removed the upper portion, and then could look down squarely upon every part at the same time. A view looking down upon the roof in the same way would be a *roof plan*, and a top view of any object is also known as a *plan*. A view of the front of the dog-house, which you would see if you could look squarely at every portion of the front at the same time, is called a *front elevation*, and the same kind of a view of the side is called a *side elevation*, while if a rear view had been necessary to show special work it would be known as a *rear elevation*, and in case there were two side elevations they would be named *left elevation* and *right elevation* to distinguish one from the other, or in the case of a building or any stationary work the elevations would be designated by the *points of the compass*. By sawing the dog-house in two, crosswise, from the peak down through the base, removing the front portion and then

looking toward the rear, you would see a sectional view of the house, and a true drawing showing this view would be called a *section* (see Fig. 92). A section may be taken through an object either horizontally or vertically (a plan taken through an object is in reality a horizontal section), and a section through the short way of an object is known as a *cross-section*, and one through the long way as a *longitudinal section*. A *perspective* drawing shows the object as you would actually see it when viewing it from one point, which is more or less similar to the view a camera would show. In this drawing the horizontal lines *converge* (approach one another) as they recede from the eye, which produces the same effect that is obtained when looking down a railroad track—the coming together of telegraph wires and tracks at a point on the horizon. A perspective of the dog-house is shown in Fig. 495, page 390.

Working-drawings are made to different

**Scales**, determined largely by the size and construction of the work. A very small object may be detailed *full-size*, while a building or a large piece of machinery would be shown at a small scale with $\frac{1}{8}$ inch or $\frac{1}{4}$ inch upon the drawing representing 12 inches on the object to be constructed, and different portions which are more or less complicated would be redrawn at a larger scale to make them clear. The drawings of the dog-house (Fig. 92) were made to a scale of $1\frac{1}{2}$ inches to the foot; that is, $1\frac{1}{2}$ inches on the drawing represents 12 inches

A Corner of the Author's Home Workroom.

(For Working Drawings of the Table and Bench see Figs. 147 and 130, Chapter VI.)

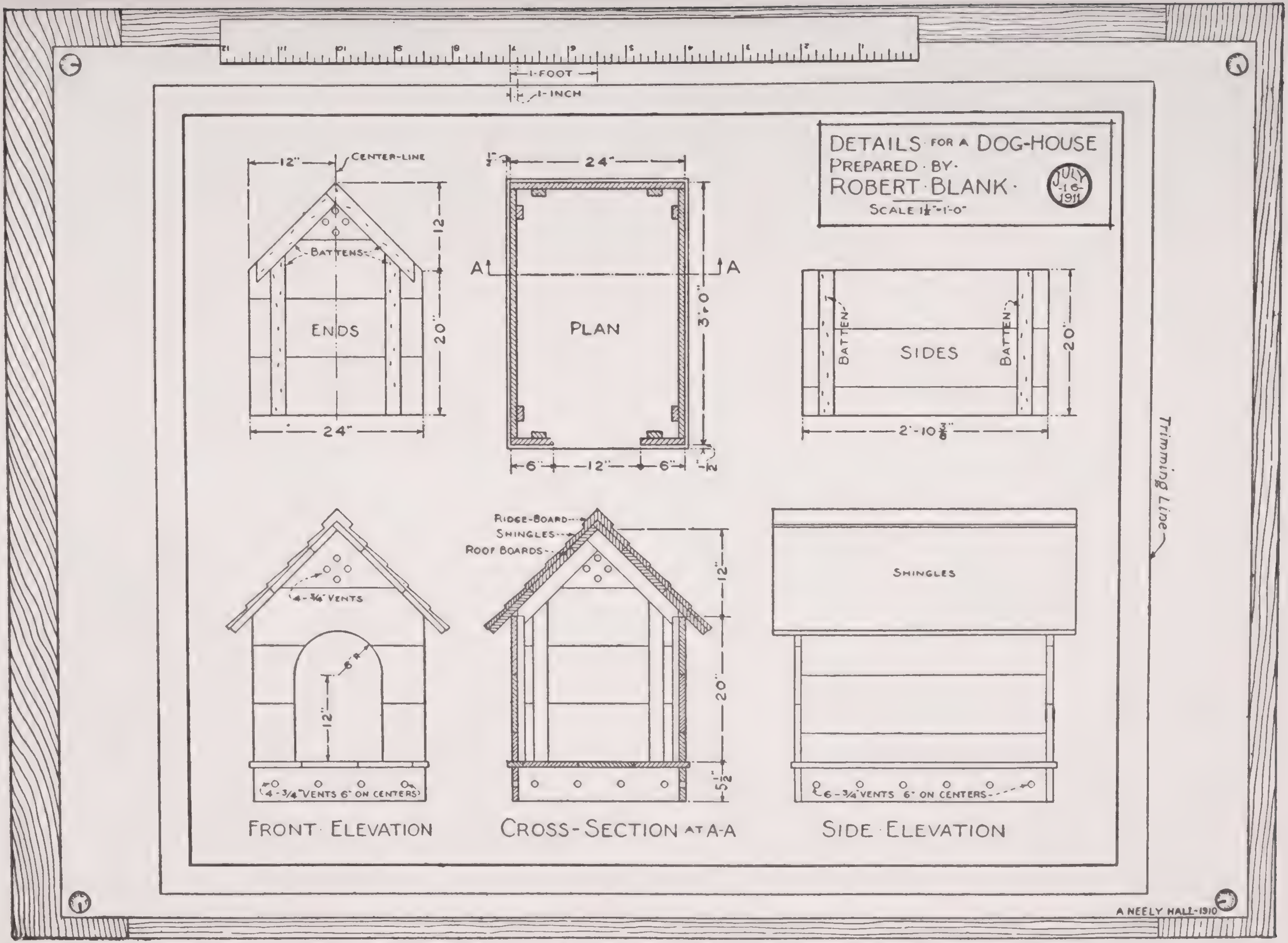



FIG. 92. — Working-drawings for a Dog-house showing how they should be laid out. (See Fig. 495, page 390.)

of the dog-house. They have been reduced considerably from this size in order to show them upon the page, but the ruler across the top indicates the original size to which they were drawn. Maps and printed drawings reduced to odd sizes, as in this case, have a graduated scale placed upon them, but the scale of working-drawings is usually expressed in this form: Scale 12″ = 1′-0″ (*full size*); Scale 6″ = 1′-0″ (*half size*); Scale 3″ = 1′-0″; Scale $\frac{1}{4}$″ = 1′-0″; Scale $\frac{1}{8}$″ = 1-′0″, etc. The mark ″ stands for *inch* or *inches* and the mark ′ for *foot* or *feet*.

Every boy should be able to prepare his own working-drawings in order that he may work out his own designs for furniture, wagons, boats, kites, airplanes, etc., and no important work should be attempted before it has been carefully drawn out upon paper, for, as the maxim goes,

"Working without a plan is sailing without a compass,"

and work so constructed is bound to show defects either in the design or in the misfitting of parts. The furniture described in the following chapter is completely detailed and will give you a good idea of how such work should be laid out, but many of the other articles described in this book are illustrated only by sketches or perspective drawings, and before making these you should prepare drawings showing the work as you have determined to make it.

**A Drawing Outfit** does not need to be an expensive

one, but as in the purchase of any kind of tools it pays in the end to buy only the best of materials; these are usually to be found in the medium-priced equipment.

**A Drawing-board** may be made by cleating together several boards as described on page 70 and illustrated in Fig. 85, but you can buy one so cheaply that it hardly pays to try to make one. The board must be absolutely true upon the left-hand edge, and the wood must be well-seasoned and free from *winding*, *knots* and other defects, which points are taken care of in the boards you buy. A good size for small drawings is a student's board, size 16 inches by 22 inches (Fig. 93). The board may be placed upon your desk while you work, or you may make

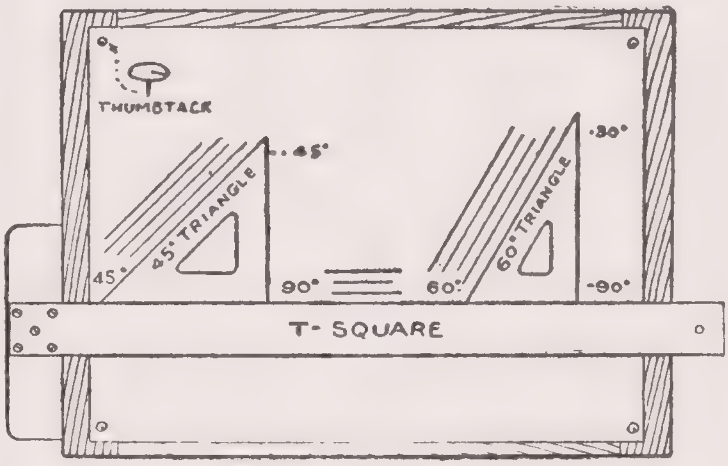



FIG. 93. — A Student's Drawing-board (size 16″ × 22″) and T-square and Triangles.

**A Drafting Table** such as is shown opposite page 86, if you wish. This table has a large drawing-board for a top, but an ordinary table top may be constructed instead if you have a small drawing-board to use on it. Working-drawings for the construction of the table are given in Fig. 147, page 132.

**A T-square** is used as a guide for the pencil in drawing horizontal lines, and a guide for the *triangles* for oblique lines. The crosspiece upon the end slides along

the left edge of the drawing-board and is moved with the left hand. A

**45-degree Triangle** is required for drawing oblique lines at an angle of 45 degrees, and a

**60-degree Triangle** for drawing oblique lines at angles of 60 and 30 degrees (Fig. 93). With the addition of a *ruler*, a couple of *pencils*, an *eraser*, and

**Compasses**, a boy will have as large an outfit as he probably will require for making drawings for shop use. Figure 94 shows a cheap pencil-compass which will serve the purpose, but if you can afford a pair such as is shown in Fig. 95, you will be better equipped for a greater variety of work. In the illustration of the latter pair, *A* represents the *body* of the compass, *B* the *needle point* which fits into one leg, and *C* the *pencil point* which fits into the other leg, while *D* and *E* are *divider points* which may be substituted in place of the needle and pencil points to form a pair of *dividers*. *F* is the *pen point* which is used in place of the pencil point for drawing in ink, and *G* is the *extension bar* with which either leg of the compass or divider may be extended.

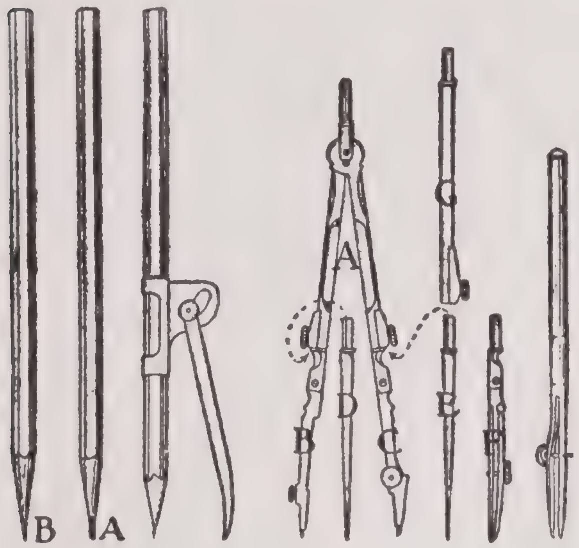



FIG. 97. FIG. 94. FIG. 95. FIG. 96.

FIG. 94. — A Cheap Pencil-compass.

FIG. 95. — Compass with Pen, Pencil, and Divider Points.

FIG. 96. — Ruling-pen.

FIG. 97. — Chisel-shaped and Pointed Pencil Ends.

Swing the compass with one hand, as shown in Fig. 98. For drawing ink lines other than arcs of circles, a

**Ruling-pen** is necessary (Fig. 96). The ruling-pen must be held in a perpendicular position, with the ends of the fingers resting upon the T-square as shown in Fig. 99, so they will slide along the T-square easily. The thickness of the lines is governed by turning the screw upon the pen, which draws together or spreads apart the two blades. The ink is dropped between the blades by means of the quill upon the end of the cork furnished with the bottles of drawing ink (Fig. 102). Figure 100 shows

FIG. 98. — How to swing a Compass.

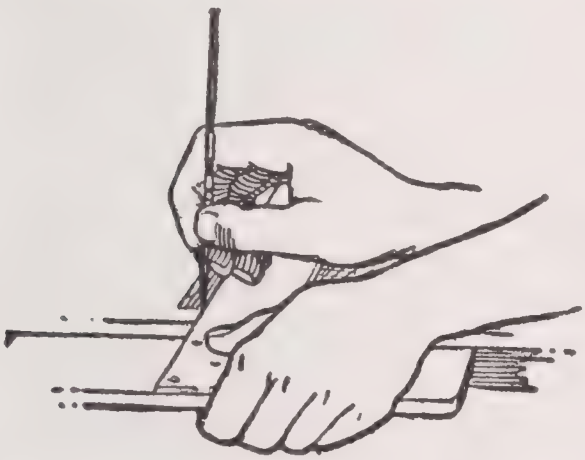


FIG. 99. — How to hold a Ruling-pencil.

**A Set of Instruments** which, in addition to the compass $A$, compass adjusting key $B$, pen point $C$, extension bar $D$, and ruling-pen $E$, has a pair of dividers $F$, a small sized ruling-pen $G$, a small pair of dividers $H$ (*bow-dividers*), a small pencil-compass $I$ (*bow-pencil*), a small pen-compass $J$ (*bow-pen*), and a box of *leads* $K$. A moderate priced set of these instruments will cost about $6.50.

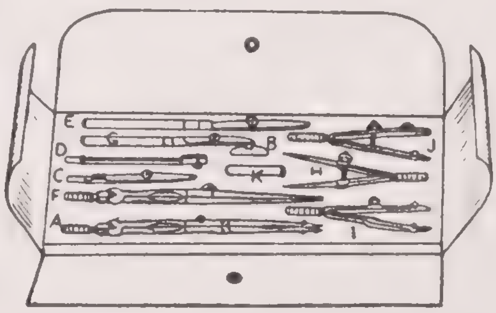


FIG. 100. — A Students' Set of Drawing Instruments.

For laying off measurements, an ordinary

**12-inch Ruler** (Fig. 92) will do, but at a slight additional cost a specially prepared

**Scale** may be purchased. One of these is a time saver in making scale drawings. Some scales are made flat like a ruler, while others are triangular in shape as shown in Fig. 101. Upon the triangular scales eleven sets of graduations are provided — 12″ (full size), 3″, $1\frac{1}{2}''$, 1″, $\frac{3}{4}''$, $\frac{1}{2}''$, $\frac{3}{8}''$, $\frac{1}{4}''$, $\frac{3}{16}''$, $\frac{1}{8}''$, and $\frac{3}{32}''$. In the illustration the $\frac{3}{8}''$ and $\frac{3}{4}''$ graduations are shown along one edge and 3″ and $1\frac{1}{2}''$ divisions along the other. Each end division

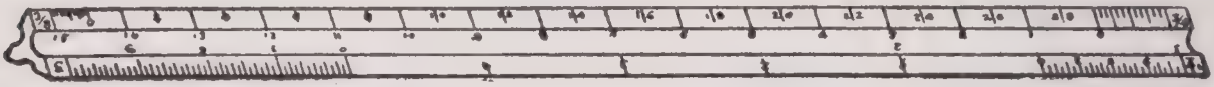


FIG. 101. — A Triangular Scale.

of these is also divided into twelve parts, each of which for that particular scale represents 1 inch. Flat scales are made with four or eight different kinds of divisions according to whether one side or both sides are graduated.

**Drawing Pencils** are made in various grades designated by letters, ranging from 9H, which is very hard, down to 6B, which is very soft. A 6H pencil is usually used in machine drawing, while a 3H is about the hardest used in architectural drawing. If you wish to use ordinary pencils, get a No. 4 or No. 5 (equivalent to 2H and 3H drawing pencils) for drawing upon hard paper, a No. 2 (equivalent to a B) for a medium soft pencil, and a No. 1 (equivalent to a 3B) for a very soft pencil. For

drawing straight lines, a pencil should be sharpened *chisel-shape* (*A*, Fig. 97), which may be done by rubbing it upon a piece of No. 00 sandpaper, and for lettering and drawing curved lines it should be rubbed to a point (*B*, Fig. 97). For ordinary lettering in ink, Gillott's Nos. 303 and 170

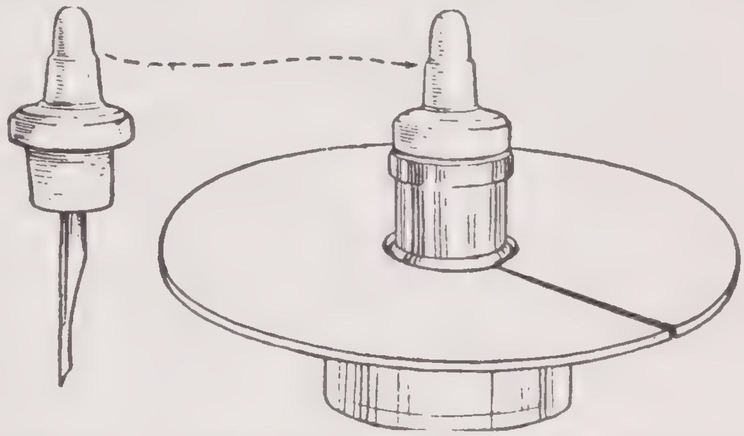


FIG. 102. — Drawing-ink Bottle with Cardboard Collar to prevent Upsetting.

**Pens** are most satisfactory, while a No. 659 should be used for very fine work.

**Drawing Ink.** Specially prepared India ink (Higgins' Waterproof India Ink is almost universally used) should be bought for use in preparing ink drawings. This comes in small bottles with a quill upon the end of the cork with which to fill the ruling-pen (Fig. 102). Drawing inks may also be had in colors.

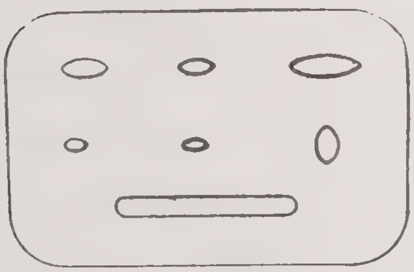


FIG. 103. — Erasing Shield.

**An Ink Eraser and a Pencil Eraser** are also required, and an

**Erasing Shield** (Fig. 103) is a great convenience as a protection to the lines close to those which you wish to erase, as an opening of the proper size may be placed over that portion, and the surrounding lines will be covered. One of these shields can easily be prepared out of a piece of thin brass.

About the most unfortunate thing which a young

draftsman experiences is the upsetting of his ink-bottle on a drawing after working perhaps three or four days upon it. This is certain to happen sooner or later, if the bottle is set without a holder upon the table, and frequently when the boy is careless. Figure 102 shows a simple protection, consisting of a cardboard collar cut to fit over the neck of the bottle and of a large enough diameter to make it impossible to upset the ink.

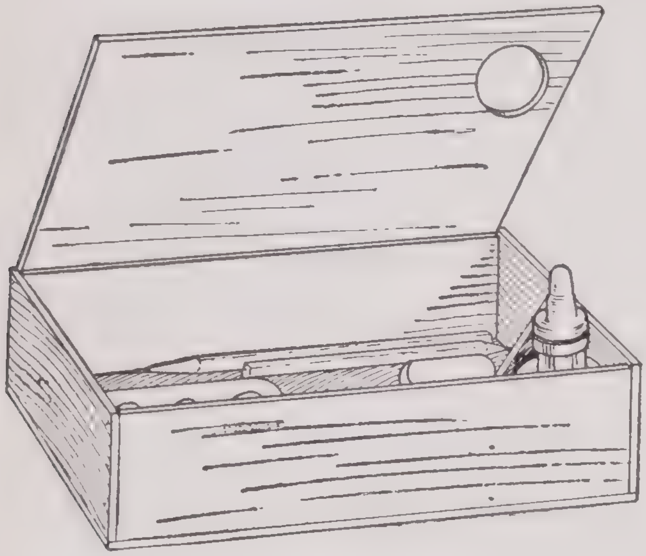


FIG. 104. — Cigar-box Pencil Box and Inkstand.

**A Home-made Pencil Box and Inkstand** such as is shown in Fig. 104 is very convenient. It is made out of a cigar box. One corner of the box is partitioned off to hold the ink-bottle, and the cover has a hole cut through it so it will fit over the top of the cork when closed. The box will serve the purpose of a receptacle not only for pencils, but for your pens, thumb-tacks, erasers, and erasing shield as well.

You may use small 1-ounce flat-head tacks for holding down drawing-paper, but these are not as easily removed as regular

**Thumb-tacks**, the best form of which is shown in Fig. 93.

**Drawing-paper** specially prepared for pencil or ink may be purchased in sheets or rolls. For common use, how

ever, butchers' Manila wrapping paper will serve the purpose, and the back of smooth medium-weight wall-paper has a good surface. Out-of-date stock of wall-paper can be purchased for a few cents a roll. The chief trouble with the common paper is that it roughens up when erased, but this will not be a serious objection for your shop drawings, and when you wish to prepare better appearing drawings, you may copy them upon better paper.

The white-lined drawings which you have seen upon blue paper are known as

**Blueprints** and are printed upon sensitized paper in the same way that a photograph blueprint is made from a plate or film. The negative in this case is prepared upon

**Tracing-cloth**, which is a linen specially prepared so as to be very transparent, or upon

**Tracing-paper**, which is a very transparent paper. The cloth or paper is tacked down over the drawing, and then everything is traced off upon it with ink exactly as it is upon the drawing below. The cloth has a glazed and a dull side, the former the right side, but the latter the one generally preferred by draftsmen as the better working surface. To make the ink flow smoothly, *talcum powder* is dusted upon the cloth and rubbed over it with a rag to cut any oil which may have collected upon the surface. Ink lines erase very easily from the cloth, and all pencil lines and dirt may be cleaned off after the tracing has

been finished by wiping with a rag wet in benzine (*do not use water*, for it will ruin the finish surface on the cloth), which makes the use of the cloth for ink tracings almost universal. Tracing-paper is used, generally, for making pencil copies of drawings, and for making one drawing over another when the same measurements are to be used in both, as will be explained later.

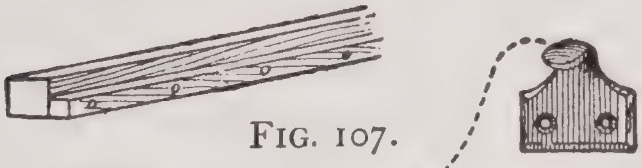


FIG. 107.

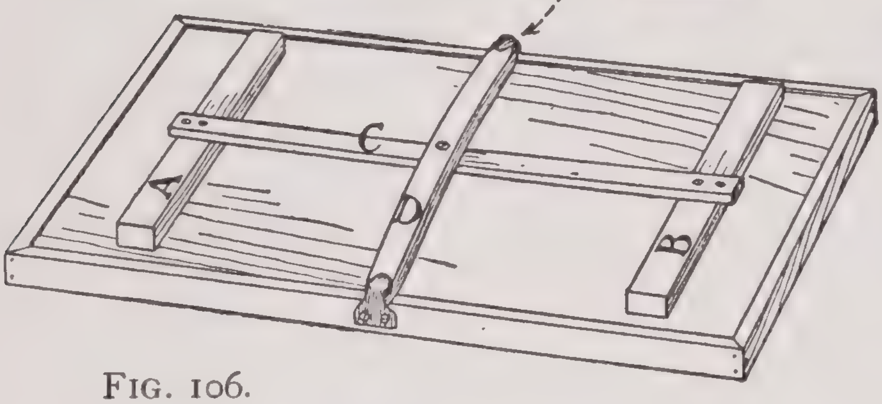



FIG. 106.

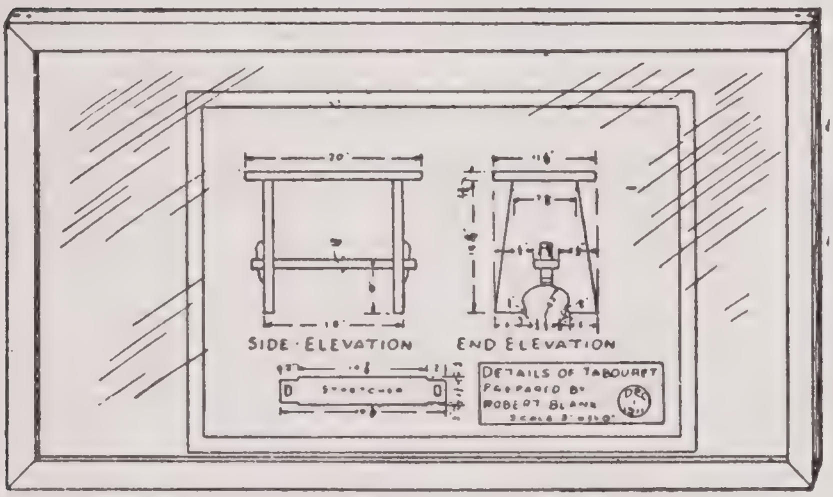



FIG. 105.

FIGS. 105–107.—Details of Home-made Blueprint frame.

After a tracing has been prepared it is placed in the printing-frame upon a piece of clear glass and a piece of blueprint paper is placed over it, then the paper is exposed and washed in the same way that an ordinary blueprint is made. If you own a photograph printing-frame, you can make your drawings to a small enough scale to fit it, but it is a simple matter to construct

**A Home-made Printing-frame.** A good scheme is shown in Fig. 105. This may be made out of a picture-frame, or a similar frame can be made with the corners mitered and a rabbet formed on the inside by tacking narrow strips to the frame strips, as shown in Fig. 107. The wooden back must be provided with a spring attachment to make an equal pressure upon all parts, so there will be perfect contact between the paper and tracing at all points (Fig. 106). Make this back out of $\frac{1}{2}$-inch stuff, in one piece if possible, and fasten a cleat across it near each end to keep it from warping (*A* and *B*, Fig. 106), then cut strip *C* of the proper length to reach from *A* to *B* and strip *D* to reach from side to side of the frame. Screw *C* and *D* together at their centers, boring a hole through *D* for the screw to run through so this strip will turn easily, and screw the ends of *C* to *A* and *B*. Fasten a metal sash-lift in the proper place upon each side of the frame, and bevel off the ends of strip *D* enough so they will slip under them. The strips must be cut to the proper thickness so that strip *D* will have to be bent in the shape of a bow to slip its ends under the sash-lifts; this places a pressure upon strip *C*, which transfers it to strips *A* and *B*, and the latter distribute it over the back of the frame. The back of the frame should be covered with a piece of thin cotton-flannel; this must be glued in place and smoothed out carefully so there will be no wrinkles. A cheaper grade of paper than that used for photographic work is manufactured for blueprinting, and

this can be purchased in rolls put up in sealed tubes. Use a small piece of paper to make a test print upon, to determine the proper length of time for exposure.

**Preparing Working-drawings**. Before laying out a set of working-drawings, the general plan of the piece of work must be sketched out, and the various dimensions and the method of construction determined upon. All this preliminary work may be done very roughly.

The first part to lay out is the plan, then the elevations and sections. It is often necessary to work out a section before the elevations, or at the same time, as in the case of a house where the heights of the exterior features are determined by the wall and floor construction. By placing the drawings as shown in Fig. 92, the lines of the plan may be continued down (*projected*) for the cross-section, and the heights may be projected horizontally to the left for the front elevation and to the right for the side elevation, while the corner spaces may be filled with detail drawings. In the details of the dog-house, the side lines of the ends were projected up from the front elevation, and those of the sides were carried up from the side elevation. Although there are many other schemes for laying out a set of drawings, this is about the simplest method for you to use in your work, which will be more or less simple. In more complicated work it is general practice, especially in the planning of buildings, to place a piece of tracing-paper over the plan after that has been laid out, and to lay out the section upon this, then to place another

piece of tracing-paper over the section and lay out a front elevation upon this. The transparency of the paper makes it possible for the draftsman to see through the sheets and, without having to lay out the main widths and the heights again, to mark them off upon the top sheet just as they are located upon the plan and section sheets below. After the front elevation has been laid out, one of the side elevations is prepared in the same way, from the plan and either the front elevation or section; the opposite side elevation and the rear elevation are made by reversing the side elevation and front elevation sheets and tracing off the similar portions and changing the rest to suit the plan.

Lay out your drawings with a light line first, then check up your measurements, and if everything appears, all right, go over the work and make all the *outlines* heavy. *Cross-hatch* (shade with diagonal lines placed at equal distances apart) all portions of the plan and section which are "cut through," in order to show which is in section and which in elevation, and change the direction of the cross-hatching upon adjoining pieces to accent the point where one piece ends and another begins. After the drawing has been completed,

**Draw Dimension-lines** upon the plan, section, elevations, and details wherever measurements are necessary (these should be broken lines and be lighter than the outlines); then fill in the dimensions in feet and inches.

Besides the heavy and light full lines, and the broken

dimension-lines, you will have occasion to use a *dot-and-dash* line for *center-lines* and to indicate upon the plan where sections have been made (Fig. 92), and the *dotted* line to indicate upon plan, sections, elevations, and details the work concealed and that which is above or upon the opposite side (see *Furniture Working-drawings*, Chap. VI), and to show where material is to be cut or folded (see Fig. 262, page 194).

Always leave a space in one corner of the sheet, preferably the upper or lower right-hand corner, in which to

**Letter the Title of your Drawing**, your *name*, the *scale* of the drawing, and the *date* upon which it is finished (Fig. 92). This lettering may be separated from the drawing by heavy lines. Draw

**Marginal Lines** around the outside of the drawing, and leave a margin of about $\frac{1}{2}$ inch upon the sheet outside of this line. Plain

**Gothic Letters** look best for titles and notes, when well made. Always rule two light horizontal guide-lines between which to letter, so that it will be easy to keep the tops and bottoms of the letters on a line, and if you have trouble in making vertical lines, you may use a triangle with which to straighten them.

# CHAPTER VI

## EASILY MADE FURNITURE

If you have carried out the exercises of the preceding chapters and studied carefully all instructions, there is no reason why you should not be prepared to undertake some simple cabinet making. This work will be a better test of your skill as a craftsman than would any other kind of carpentry.

If I am not mistaken, what you boys want to make in furniture are things which will be of practical use for your own room and for other parts of the house, and things which will be suitable to give away and to sell. The articles described upon the following pages have been selected with these points in mind. After you have turned out a few well-made pieces so you will have some good samples to show, you should have no difficulty in securing enough orders at fairs, and from friends and relatives, to enable you to work up a profitable little business, especially a month or so before the holidays, when practical gifts are much in demand.

Many boys are earning money in this way. An interesting example is the factory of "The Juvenile Manu-

facturing Company," an organization of six energetic boys of Dayton, Ohio — Masters Charles Deeds, Pres. and Gen. Mgr., Fulton Davisson, Jr., Vice Pres. and Supt., Robert Canby, Secy., Charles Whidden, Treas., and Stanley Raugh and Evan Whidden. These boys are doing a flourishing business, and from the excellent work they are turning out it is no wonder that they are succeeding so well. The firm has issued an attractive catalogue of 8 pages containing illustrations of their line of goods, a group photograph of the officers and Board of Directors, an exterior view of the office and factory, — which is fitted up in a playhouse belonging to one of the boys, — and two views of completed orders loaded on to automobiles ready for local delivery and shipment to out-of-town customers. The catalogue states, in part, the following: —

"The plant is running Mondays, Thursdays, and Fridays after school, and all day Saturdays. Visitors are welcome on Saturdays.

"Only the best materials are used, and no cheap laborers are employed; the officers and Board of Directors do the work themselves.

"The purchaser of any article produced by this Company is not only getting more value for the money paid than he could get at any store, but at the same time is encouraging a Company of energetic little business men to get a training which is most practical.

"Our business is meeting with great success. We are always behind with our orders. Our customers are our best advertisers because we give them more for their money than they can get anywhere else."

You will have to hustle some, boys, to accomplish what these lads have, but there is no reason why you

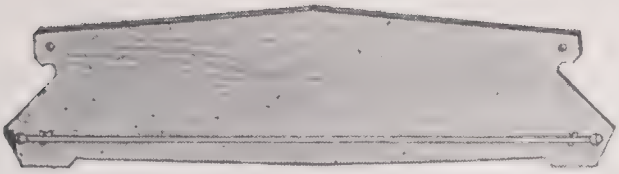


Fig. 111.

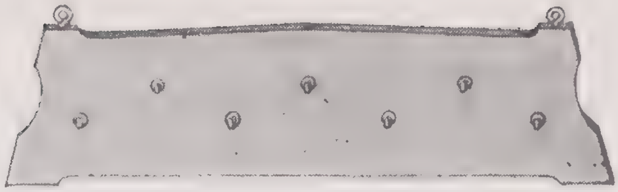


Fig. 110.

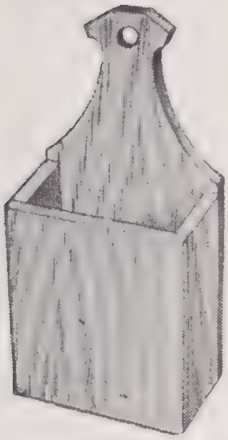


Fig. 108.

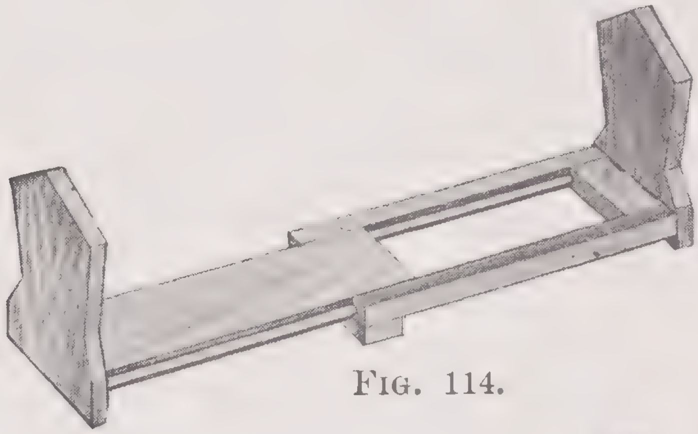


Fig. 114.

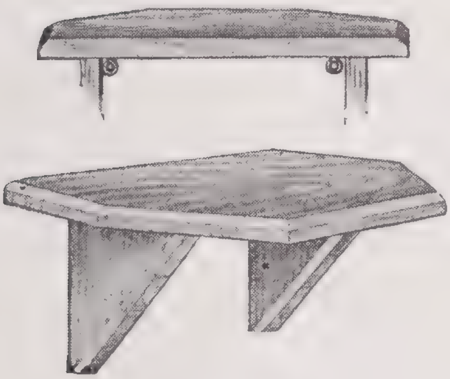


Fig. 109.

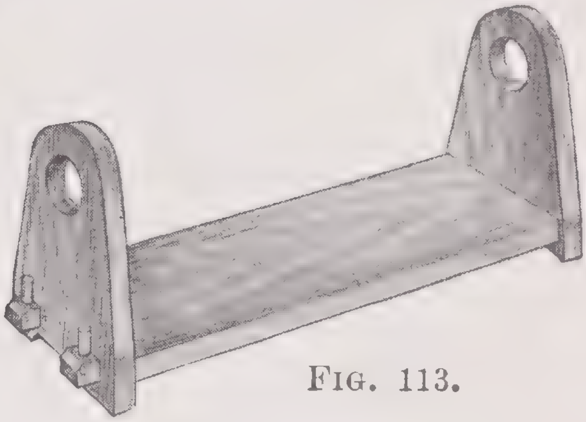


Fig. 113.

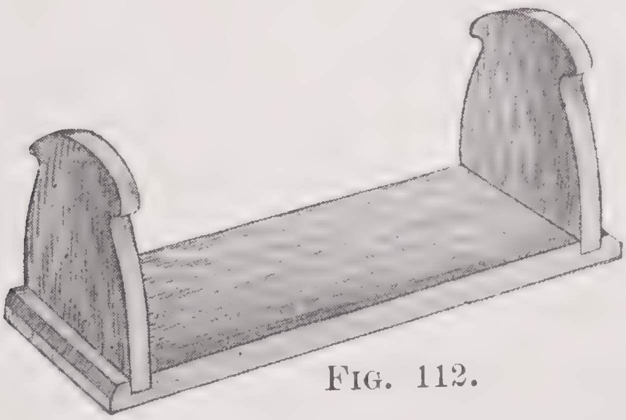


Fig. 112.

Fig. 108. Whisk-Broom Holder.
Fig. 109. Clock-Shelf.
Figs. 110 and 111. Necktie-Racks.
Figs. 112, 113 and 114. Book-Racks.

cannot make a success of a similar enterprise in your own home town if you know of a number of fellows who would be good workers and would have enough stick-to-it-iveness in them to keep up an interest in the work.

The articles shown opposite page 104 are especially good material for the beginner to start upon on account of the simplicity of their construction.

**Choice of Material.** There are a number of varieties of wood well adapted to amateur furniture making, and these are mentioned in Chapter III, while the matter of finish is discussed in Chapter IV.

**A Whisk-broom Holder** such as is shown in Fig. 108 is a handy article for a bedroom. It should be made out of $\frac{1}{2}$-inch stuff (which is $\frac{3}{8}$ inch thick *dressed*) with the different parts cut as shown in the working-drawings (Fig. 115). In order to get the two side edges of the back piece alike, first draw a center-line upon the piece of wood as shown, then lay off the dimensions each side of this. Draw the curve upon one side, then reproduce it upon the other side at an equal distance from the center-line, tracing it off with a piece of tracing-paper to get the curves alike. Lay off the tapered edges of the front piece each side of a center-line in the same way. With the front, back, and side pieces prepared, nail them together with 1-inch brads, set the brad-heads, then sandpaper, putty, and finish.

**A Clock-shelf** is a neat gift, and Fig. 109 shows one which is easily constructed. Make this out of 1-inch

stuff ($\frac{13}{16}$ inch thick *dressed*). After cutting the top and two brackets as shown in Fig. 116, bevel the upper front and end edges of the top piece and the two diagonal edges of each bracket piece, gauging the width and

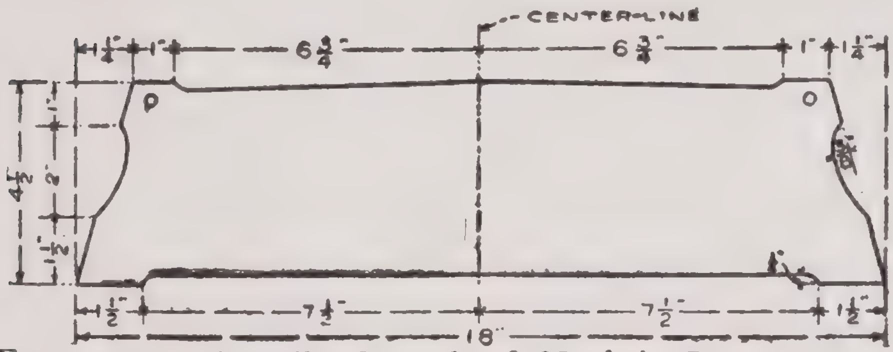



FIG. 117. — Detail of Back of Necktie Rack shown in Fig. 110.

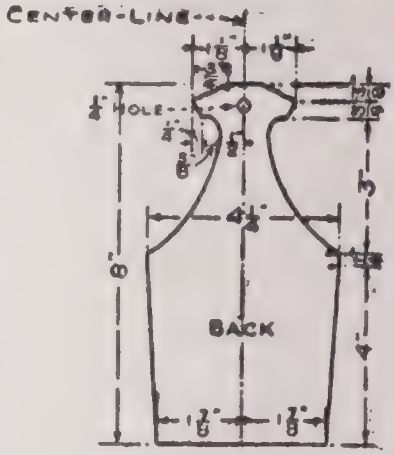



FIG. 115. — Whisk-broom Holder shown in Fig. 108.

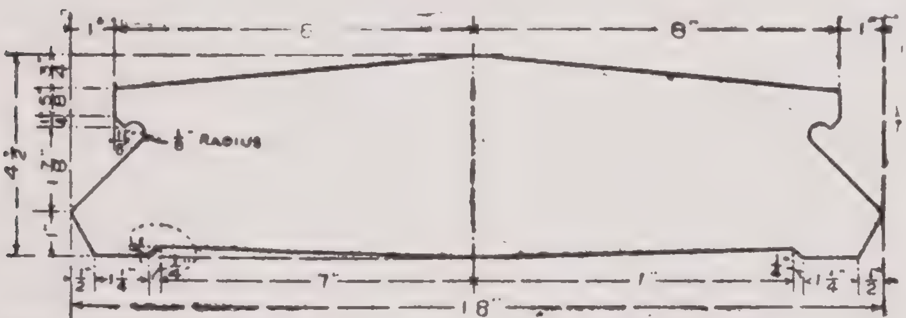
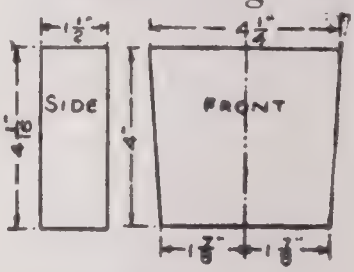



FIG. 118. — Detail of Back of Towel-rack shown in Fig. 111.



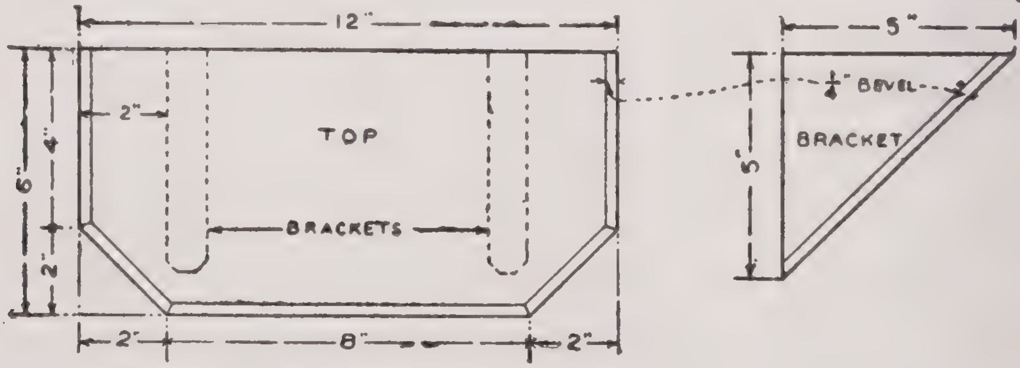




FIG. 116. — Details of Clock-shelf shown in Fig. 109.

depth of the bevels and cutting them as described on page 71 (see *Bevel*). Fasten the brackets to the top piece with $1\frac{1}{2}$-inch finishing-nails in the positions indicated by dotted lines in the drawing. In the back view

of the completed shelf (Fig. 109) is shown the method of fastening it to a wall. A screw-eye is screwed into the under side of the shelf top, just inside of each bracket, and these eyes slip over a couple of nails or screws driven into the wall in corresponding positions.

**The Necktie Rack** shown in Fig. 110 has a back cut out of $\frac{1}{2}$-inch stuff (see working-drawing for back in Fig. 117) with seven brass screw-hooks screwed into it in two rows. Scribe two pencil lines across the center of the board about 1 inch apart, then starting at the center of the length of the board, mark the location of the center hook, and each side of this locate the other hooks 2 inches apart, alternating them on the two lines as shown. Fasten two screw-eyes in the top of the board, one at each end, by means of which to hang the rack upon the wall.

In Fig. 111 is shown a rack which may be used either for a necktie rack or

**A Towel-rack.** Cut the back board out of $\frac{1}{2}$-inch stuff, laying it out according to the working-drawing (Fig. 118), and procure a short brass extension curtain-rod for the front. The rod will be furnished with screw-hooks with which to fasten it to the board; these should be screwed in so the rod will set 1 inch away for a necktie rack or 3 inches away for a towel-rack.

**Book-racks** of three forms have been designed, for they are so commonly used upon the library table of the home to keep in order the books in immediate use, that you

will probably wish to make more than one kind. In the rack shown in Fig. 112 the base piece is grooved near each end for the end pieces to fit in (Fig. 119), while in the rack shown in Fig. 113 tenons are cut on the ends of the base pieces to fit mortises made in the end pieces, and these tenons are held in place by means of pins driven into holes bored through them (Fig. 120). The latter rack possesses one advantage over the former, and that lies in the fact that its pins may be withdrawn at any time and its pieces pulled apart and put away in a compact form. To prevent splitting, do the cutting of the grooves and mortises in the members of the racks before trimming off their ends, so there will be as much wood as possible outside of the portions cut. (For making mortise-and-tenon joints, see page 61.) After the racks have been put together and finished, glue strips of felt to the bottoms to prevent them from scratching any surface upon which they stand.

**An Extension Book-rack** is a little more complicated to make than the above two, but the work is not difficult. The rack shown in Fig. 114 is 16 inches long between the ends when pushed together and $28\frac{3}{4}$ inches long when extended. Figure 121 shows the details for this rack. The base is made out of a 1-by-4-inch tongued-and-grooved board, a piece about 3 feet long being required, while the end pieces are cut out of 1-inch stock. The idea of using the tongued-and-grooved board for the base is that the tongues and grooves for the slides are

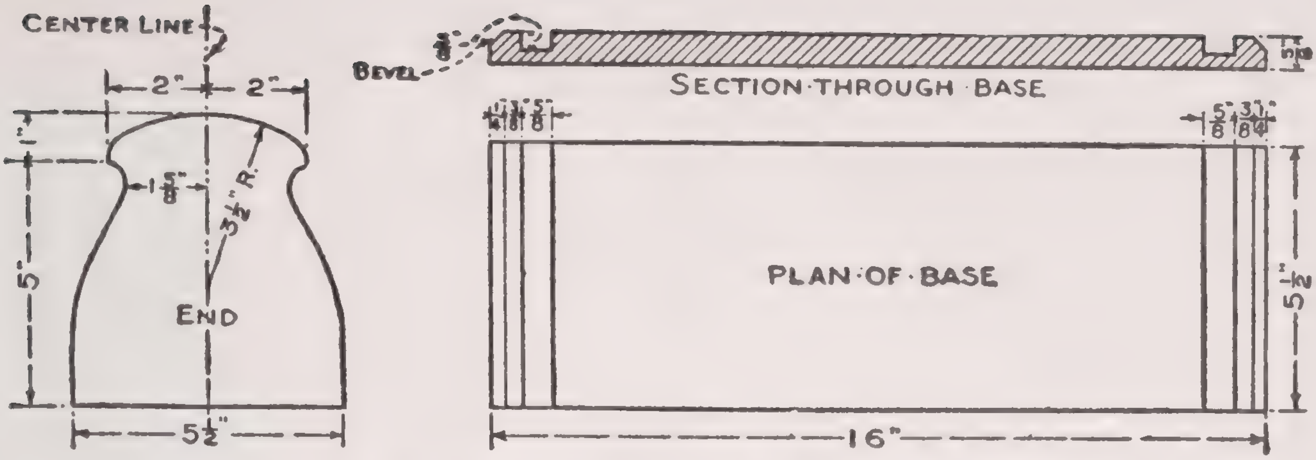



FIG. 119. — Details of Book-rack shown in Fig. 112.

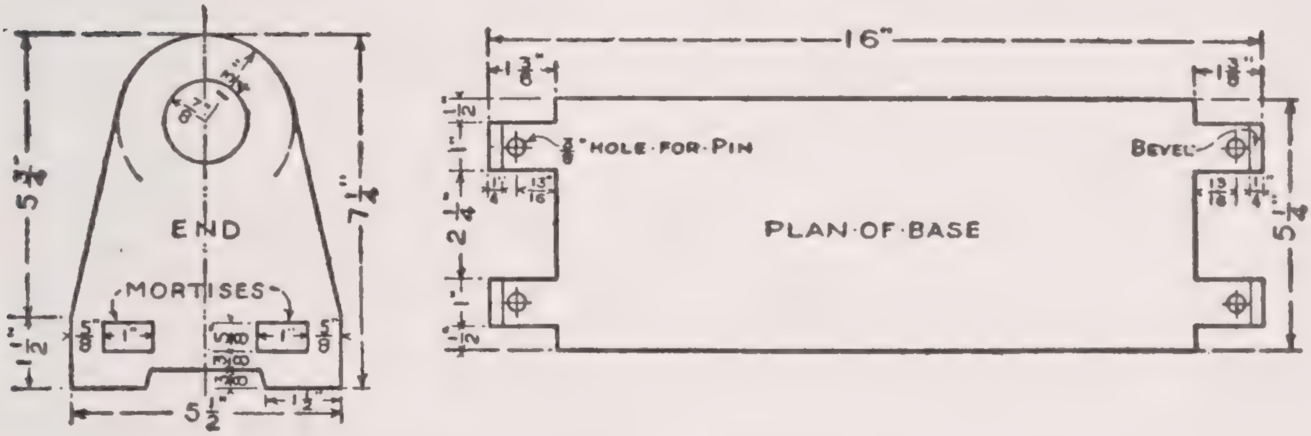



FIG. 120. — Details of Book-rack shown in Fig. 113.

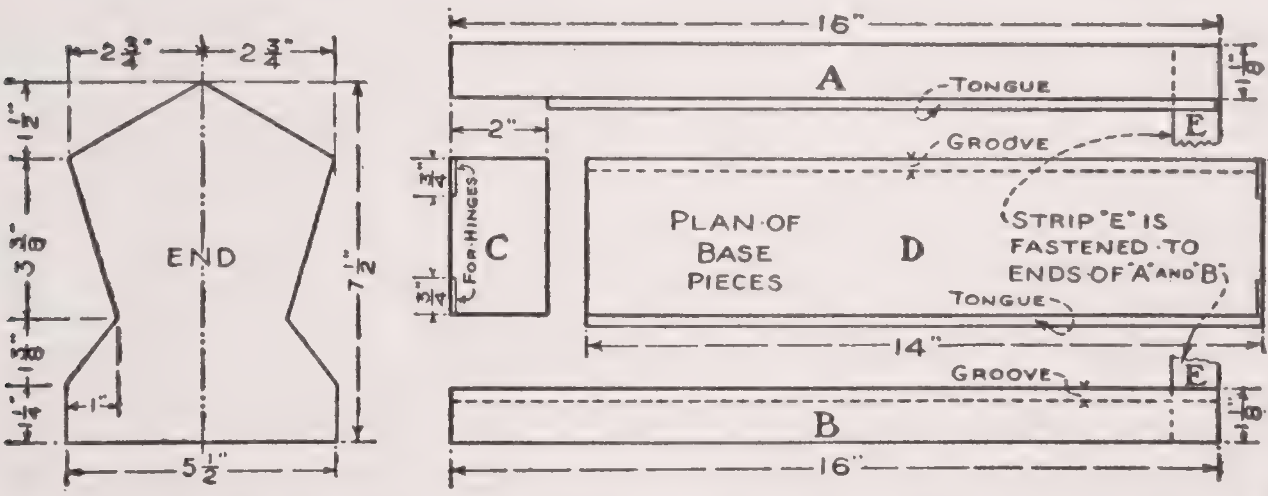
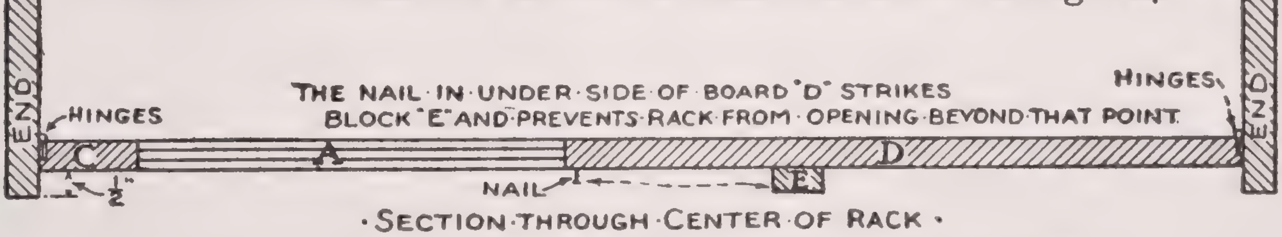



FIG. 121. — Details of Extension Book-rack shown in Fig. 114.




FIGS. 119–121. — Working-drawings for Book-racks.

already made, and you will be saved the trouble of cutting them. The tongue on piece *A* (see plan of base pieces, Fig. 121), with the exception of a 2-inch piece, is left to slide in the groove in piece *D*, while the groove on piece *B* is left for the tongue on *D* to slide in. *A* and *B* may be ripped from opposite edges of the tongued-and-grooved board. Piece *C* should be cut to the exact width of *D* (without tongue or groove), while strip *E* should be equal in length to the combined widths of *A*, *B*, and *D*. After the base pieces and the two end pieces have been prepared, nail one end of base pieces *A* and *B* to the ends of *C* and the opposite end to the upper face of piece *E*.

The ends of the rack may be nailed directly to the ends of the base pieces, but it is better to hinge them in place, as the ends may be folded flat at any time by so doing, and the rack packed away in a small space. Buy two pairs of $\frac{3}{4}$-inch by 1-inch brass hinges, and hinge one end to piece *C* and the other end to piece *D*, notching the ends of *C* and *D* just enough to receive the hinges. The drawings show the locations for the hinges. Strip *E* prevents the ends of *A* and *B* from springing apart. To prevent the rack from pulling apart lengthwise, drive a small nail into the under side of piece *D*, as shown in the sectional drawing, so it will strike against strip *E*. Glue strips of felt to the bottoms of the end pieces and strip *E*.

Of the medium-sized pieces of furniture,

**Tabourets and Plant Stands** are probably most in de-

mand, for the living-room or library is not complete nowadays without one or two of these to hold fancy vases, jardiniers, fern dishes, and potted plants. There is no limit to the number of shapes which could be devised for them, but you will probably find the three designs shown opposite page 110 of varied enough character to make the construction of one of each worth while. In presenting the working-drawings for the tabourets and plant stands, as well as those for the other pieces of furniture of an equal or a larger size,

**A List of Material** showing the exact finished dimensions of each part of the work, and the number of pieces of like size required, has been placed alongside or above the details. These lists will help you in figuring up the amount of material necessary for each piece of work, but they are not in proper shape to take to the mill or lumber yard from which to order, for it will be cheaper to combine pieces which can be cut out of boards of stock widths and lengths and do the sawing yourself. After deciding what articles you wish to construct, it is a very simple matter to estimate exactly how much material you will require. Of course, enough additional length and width over the finished dimension must be allowed on each piece for the waste produced in sawing and truing up.

In preparing the top for

**The Tabouret** shown in Fig. 122 (Fig. 126), first plane up the piece to the proper dimensions, then mark off the triangular pieces which are to be removed from the

corners and saw them off. If the work has been done carefully, the legs will fit the corners exactly right. Bevel the edges of the legs, as shown, with a chisel. The diagonal leg braces, or *stretchers*, are *halved* at their centers (see *Halved-joint*, page 60). When these have been joined together, lay them across the top piece in the position indicated by dotted lines on the plan, to see that the ends come even with, and at right angles to, the corners. Then procure No. 9, round-head, blued finishing-screws, $1\frac{3}{4}$ inches long, and screw the pieces together as shown (see *Screws*, page 72).

After making a tabouret or any other piece of furniture,

**If you find the Legs rest unevenly** upon the floor, it is a simple matter to correct the fault. Locate the short leg and put a chip under it to block it up, then cut a block of wood of just the right thickness to slip under this short leg, and, with it as a gauge, slide it around the four sides of each of the long legs, and *scribe* a knife line across each side on a line with the top of the block. It is then a simple matter to finish off the legs to these lines.

**The Tabouret** shown in Fig. 123 requires a little more work than that in Fig. 122, as the panel pieces *C* (Fig. 127) are tenoned into the rails *A* and *B*, and the ends of the rails are tenoned into the legs; but mortising is a simple operation once it has been mastered, and the mortise-and-tenon is one of the most commonly used

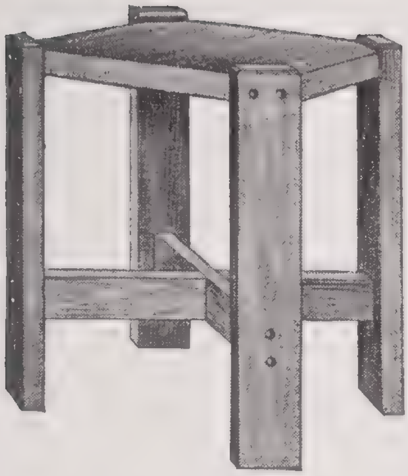


FIG. 122.

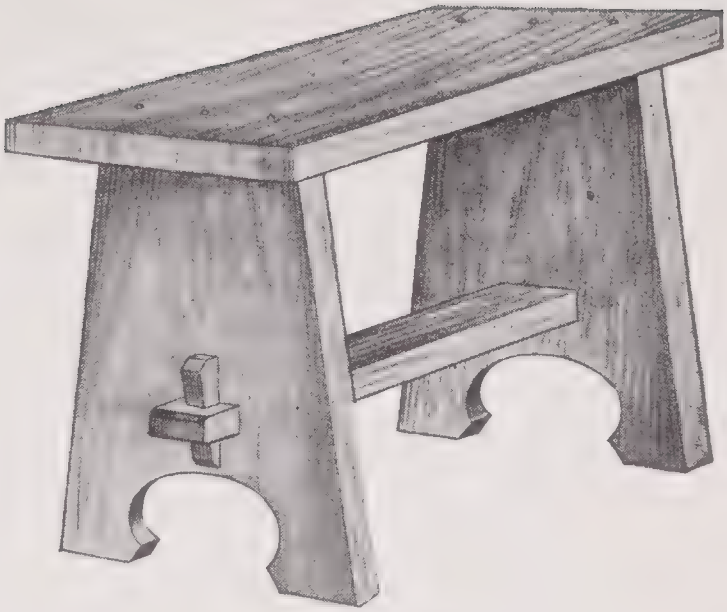


FIG. 124.

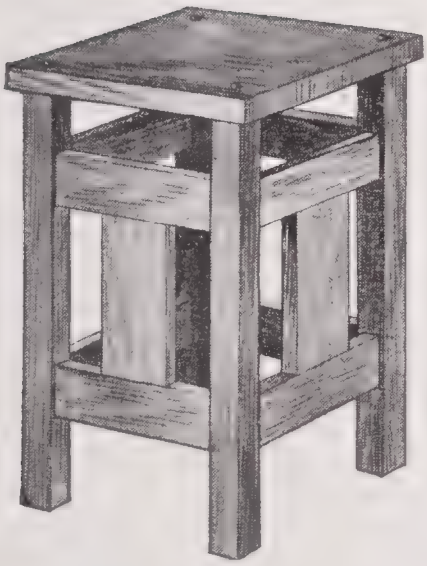


FIG. 123.

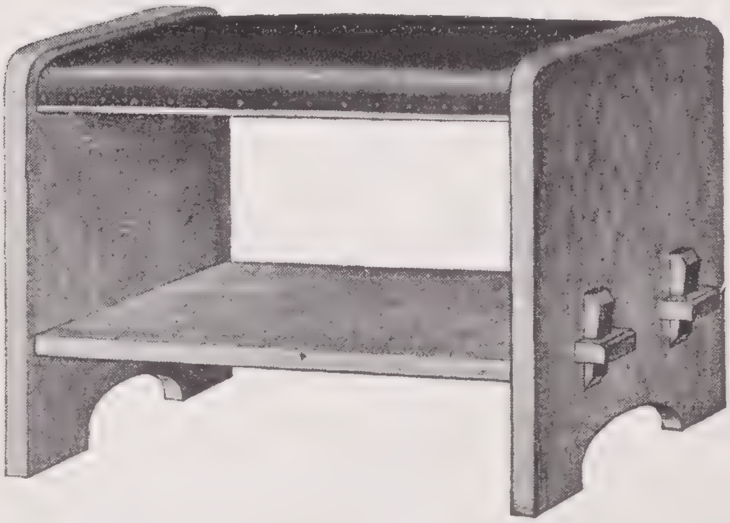


FIG. 125.

FIGS. 122 AND 123. TABOURETS.
FIG. 124. PLANT STAND.
FIG. 125. FOOTSTOOL.

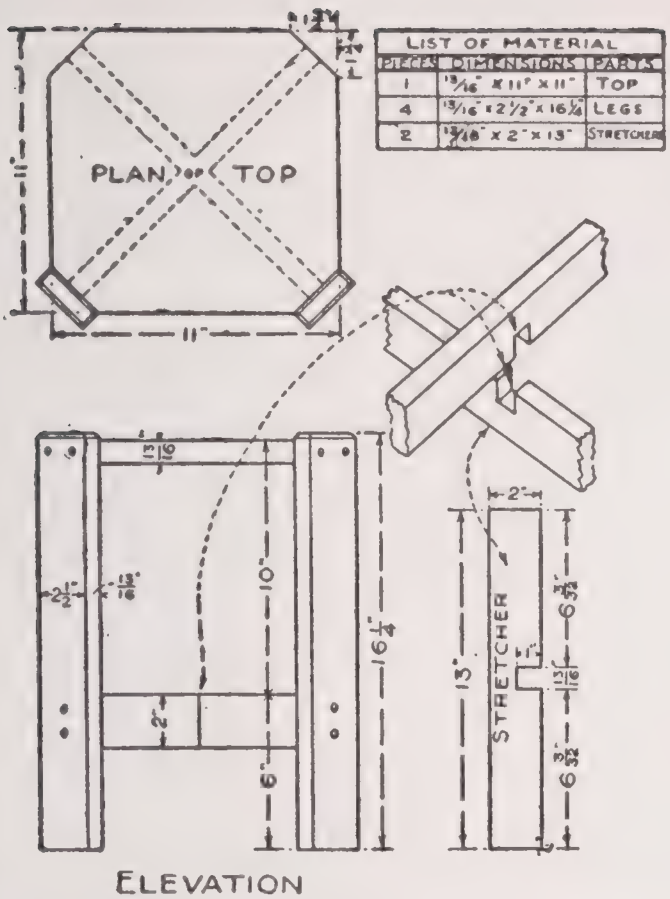



Fig. 126. — Details of Tabouret shown in Fig. 122.

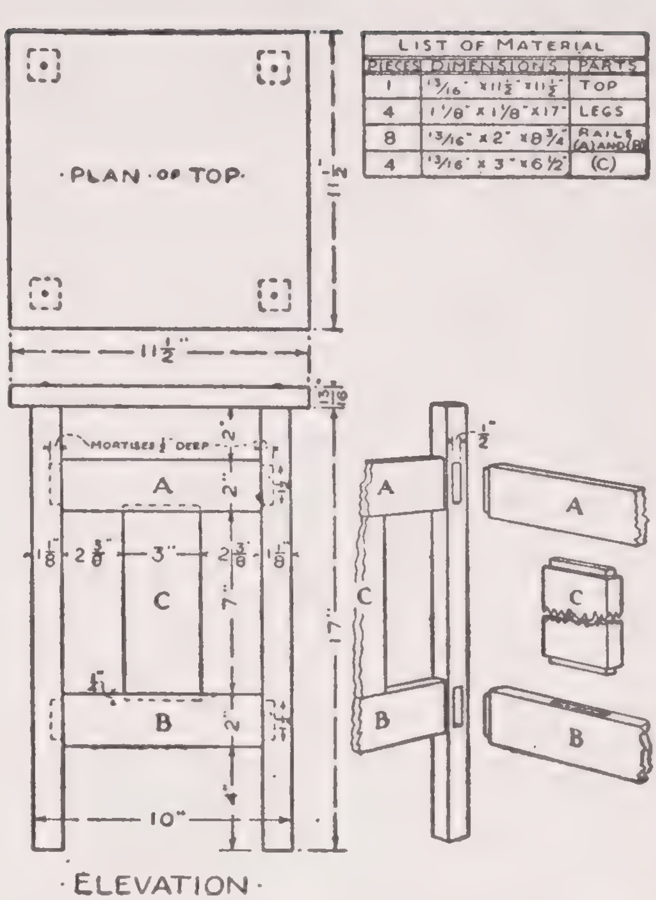



Fig. 127. — Details of Tabouret shown in Fig. 123.

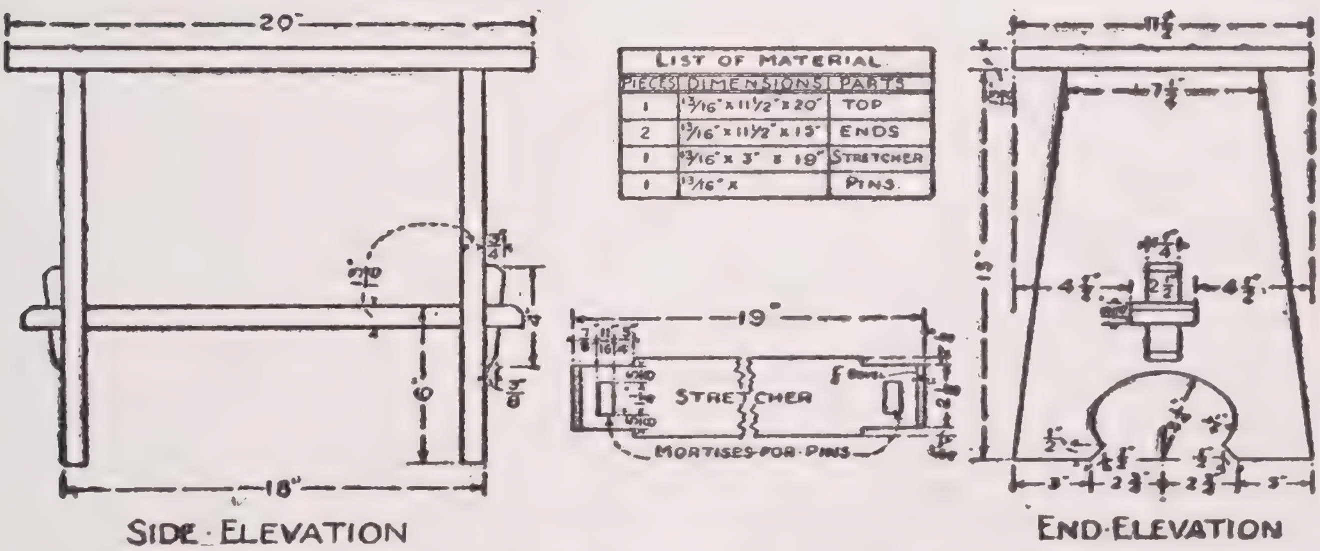



Fig. 128. — Details of Plant Stand shown in Fig. 124.

joints and one of the strongest of the cabinet-maker's methods of joining together work. The operation of *mortising* and the preparation of the *tenons* is fully described on pages 61–65. The mortises for the ends of pieces *C* need not be more than $\frac{1}{4}$ inch deep, while $\frac{1}{2}$ inch is sufficient for the ends of *A* and *B*. See description of *Bench* on page 117 for assembling mortised-and-tenoned work. Secure the top piece to the legs by means of round-head screws such as are specified for the other tabouret.

**The Plant Stand** illustrated by Fig. 124 is designed more or less along the lines of the much-used mission furniture. For the working-drawings see Fig. 128. The preparation of the mortises and tenons for the connection of the stretcher to the end pieces will be easy, if you have carried out the exercises suggested in Chapter III. The mortises are slightly *undercut* on the outer end to make them correspond with the taper on the pins, and are cut $\frac{1}{16}$ inch inside of the line of the side pieces, as you will see by looking at the dimensions on the stretcher, so that the pins will drive the end pieces tight against the shoulders of the stretcher.

**A Footstool**, with a shelf below on which the current magazines may be piled, makes a handy piece of furniture for a den or library. An attractive design for one along simple lines is shown in Fig. 125. The working-drawings for this are shown in Fig. 129. After preparing the top, the shelf, and the end pieces, fasten the shelf and

| LIST OF MATERIAL | | |
|---|---|---|
| PIECES | DIMENSIONS | PARTS |
| 2 | 13/16" × 11 1/2" × 18" | ENDS |
| 1 | 13/16" × 10 1/2" × 22 3/8" | TOP |
| 1 | 13/16" × 11" × 2'-3 1/8" | SHELF |
| 1 | 1/4-ROUND 4'-0" LONG | GROUNDS |
| 1 | 13/16" ———— | PINS, ETC |

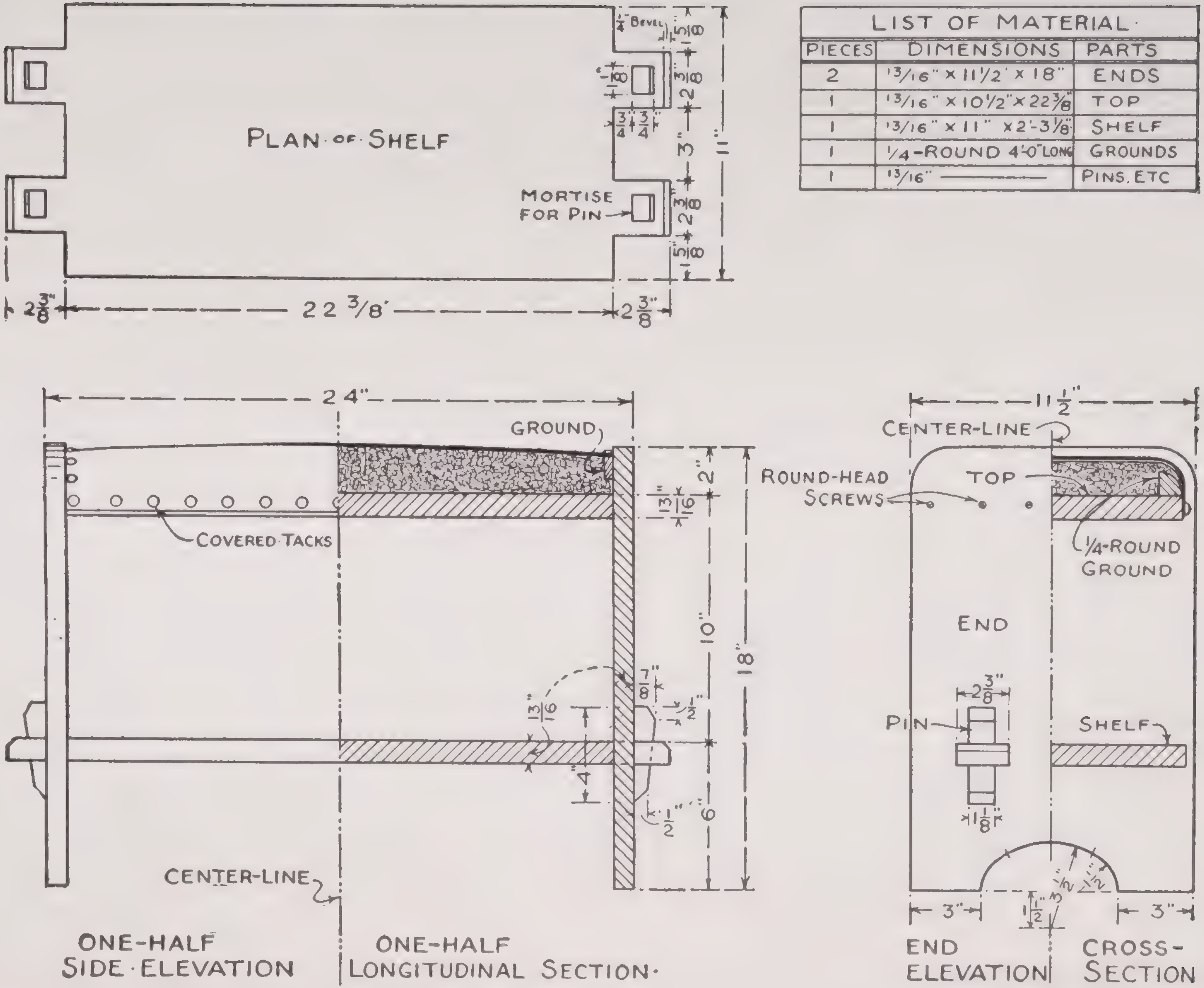



FIG. 129. —Details of Footstool shown in Fig. 125.

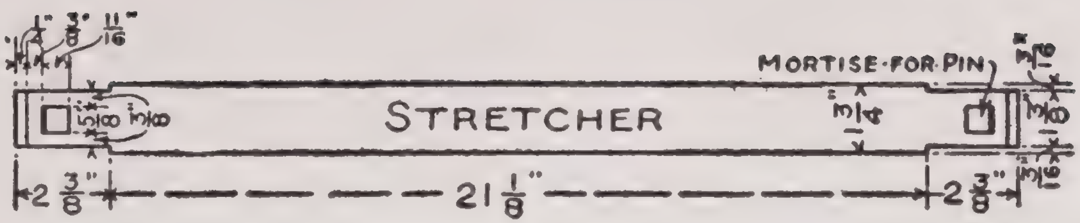
ends together by means of the pins, then secure the top between the ends with round-head screws. A strip of *quarter-round* (a small molding) should be nailed to the upper side of the top along each side edge, as shown in the cross-section, for a *ground* to hold out the sides of the upholstering, and a narrow strip should be nailed to each end piece $\frac{1}{2}$ inch below the top for a ground to tack the upholstering cover to.

**Upholstering Material** can be purchased at almost any dry-goods store. You will require some hair for filling, cheese-cloth or light-weight muslin for covering the hair, 2-ounce cut tacks for fastening the cloth, leather, imitation leather, or heavy denim for the top covering, and large-head tacks covered to match the top material. Perhaps you can get some hair from an old pillow or mattress, and your mother probably can furnish you with the cloth covering. Leather is rather expensive, about $3 a yard, while the imitation leather can be purchased for about $1.25 a yard (1 yard wide), and denim will cost 15 cents a yard. The imitation leather wears better than real leather and is probably the most satisfactory material to use. Tacks with large heads, made of a composition to match leather or imitation leather, can be bought for from 3 to 5 cents a dozen.

**To upholster the top of the Footstool**, first lay a piece of the cloth over it and tack it to the *ground* along one side and to the *grounds* along the ends, thus forming a pocket in which to stuff the hair. The cloth must be

loose enough to allow for sufficient packing, but as it will stretch considerably it may be pulled fairly tight. Pack the hair into the farther side and the two ends, first, and use a small stick with which to push it into the right places. The work is not difficult, but it must be done carefully, and all hollows must be filled out as you go along in order to make a nicely shaped top. When the near side is filled, stretch the cloth tightly over the hair and tack it to the quarter-round *ground.* With the hair held in place by the cloth covering, it is an easy matter to put on the leather or other covering. Draw a line upon the edges of the wood top to indicate the edge of the covering, and $\frac{3}{8}$ inch or $\frac{1}{2}$ inch above this draw another line parallel to it upon which to locate the tack holes; also draw a guide-line along the top of each end *ground* for the end tack holes. Space the holes upon these lines $1\frac{1}{2}$ inches from center to center, or as near to that as will make all the spaces equal, and punch holes for the tacks with a brad-awl which is a trifle smaller than they are. Turn in the edge of the covering material all around, then fasten it in place with the tacks.

**The Bench** in the photograph opposite page 86, Chapter V, is a neat-appearing piece of furniture suitable for a bedroom or any of the living-rooms. The details for its construction are shown in Fig. 130. First, prepare the legs and end rails, and mortise and tenon them as shown; then, when the pieces have been fitted properly, mark the tenons and the mortises with letters in such a way that




| ·LIST·OF·MATERIAL | | |
|---|---|---|
| PIECES | DIMENSIONS. | PARTS. |
| 4 | 1 1/8" x 1 3/4" x 18" | LEGS |
| 2 | " x " x 12 3/4" | LOWER·END·RAILS |
| 2 | 13/16" x 1 1/2" x " | UPPER " " |
| 2 | " x " x 21" | SIDE " |
| 1 | " x 1 3/4" x 25 7/8" | STRETCHER |
| 1 | " x 11 3/4" x 21 1/2" | SEAT |
| 1 | 1/4–ROUND·6'-0" LONG | GROUNDS |

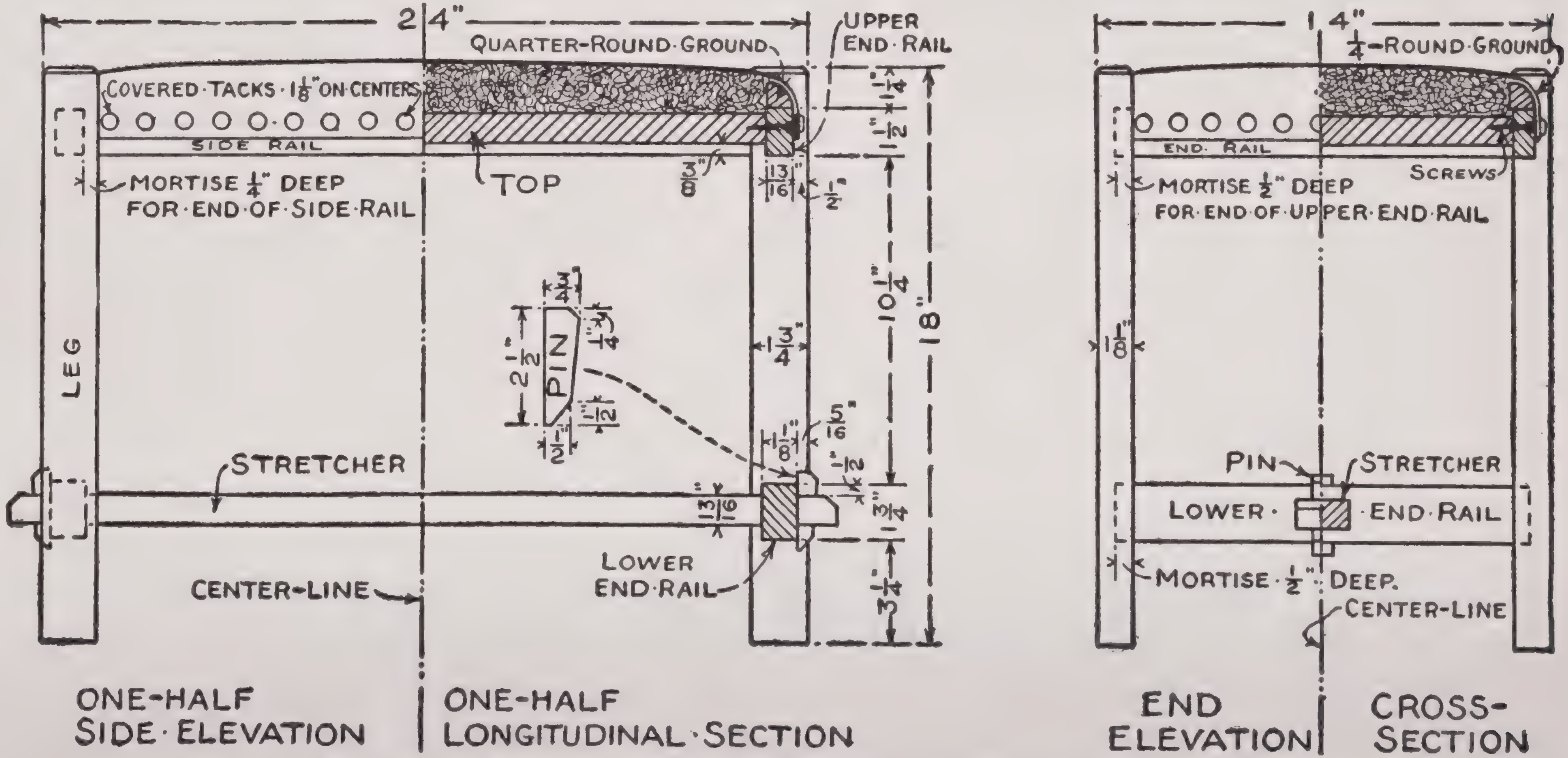



FIG. 130. — Details of Bench shown in Photograph opposite page 86.

you will know just which fits into which, which edge is up and which face turns out. Next, cut the mortises in the lower rails for the stretcher, then prepare the stretcher as in the detail, trim its ends to fit the mortises in the rails and mortise them for the pins. The side rails should be cut next. Where all the joints consist of a mortise and a tenon, as in the case of this bench, each member should be fitted and tested as cut; then, when all the members have been cut, fit them together and go over the whole piece of work, and if any trimming is required, mark the locations. Then take the members apart, trim where you have found it necessary and sandpaper each piece. The beveling of the tops of the legs and ends of the stretcher may be left until this stage of the construction (do this beveling with a chisel).

Assemble the pieces in the order in which you prepared them, and coat the end of each tenon and the inside of each mortise with glue before fitting them in place. After the glue has had time to set, cut the top piece to fit between the upper rails and fasten it in place with screws. Before boring holes for the screws, locate the places where the large tacks are to go so you can avoid them. Nail a piece of *quarter-round* along the top edge of each of the upper rails to hold in the edges of the upholstering filling.

Finish the wood, then upholster the top in the manner described for the *Footstool*. The covering material must be cut very carefully at the corners and

be turned in neatly around the legs. Space the tacks about $1\frac{1}{8}$ inches on centers.

**Magazine-racks** made upon the plan of open bookcases, but with the shelves spaced closer together, solve the problem of keeping magazines within convenient reach, and at the same time in shipshape order. A simple magazine rack that is easy to build is shown in detail in Fig. 131.

As the ends of this spread out at the bottom, the end pieces and the shelves must have their ends cut off on the diagonal. The way to get the proper angle for trimming off these ends is to lay the end pieces upon the floor on their edges, at the given distances apart, and then tack a strip across the edges near the top and bottom to hold them temporarily in that position. Then place the finished top piece against the tops of the end pieces and you will see just how much trimming they require. If you have a bevel (Fig. 34, page 26), set it to this angle and mark off the ends of each end piece accordingly; also mark off the shelf ends. Without the bevel the work may be done with a square, but be very careful to lay out each end of each piece the same, or the pieces will not fit satisfactorily. The shelves and top are fastened to the end pieces with round-head screws.

The magazine-rack shown in Fig. 132 has shelves of equal length, but the widths vary, as is shown in the

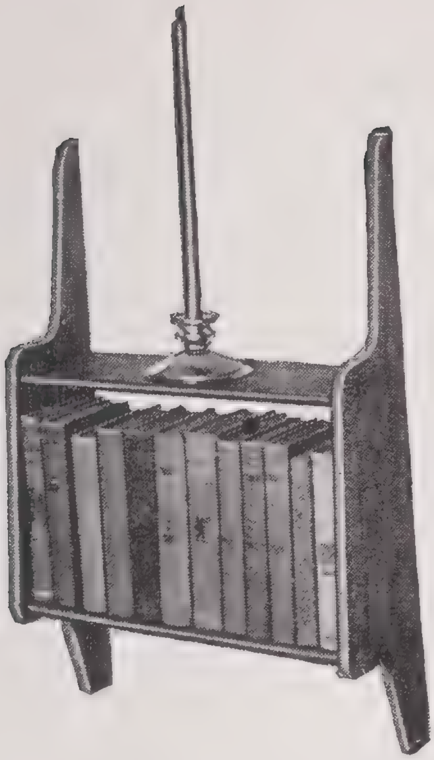


FIG. 133.

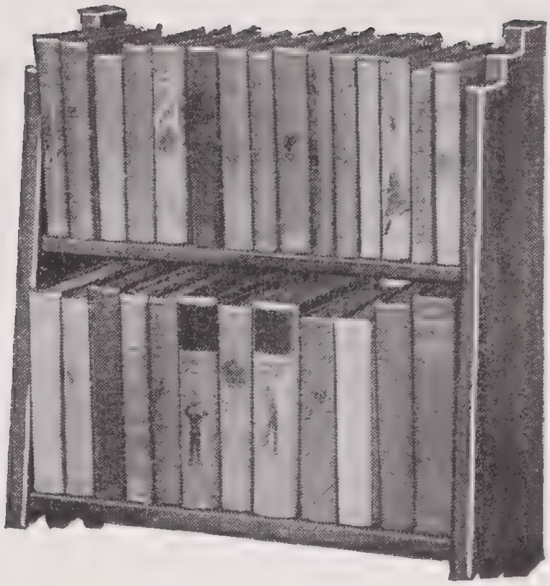


FIG. 134.

WALL BOOK RACKS.

FIG. 135.—A Fireplace Screen.

| · LIST · OF · MATERIAL · | | |
|---|---|---|
| PIECES | DIMENSIONS | PARTS |
| 1 | 13/16" × 11½" × 19" | TOP |
| 2 | " × 11½" × 3'-3 3/16" | ENDS |
| 1 | " × 11" × 14" | SHELF |
| 1 | " × 11" × 15" | " |
| 1 | " × 11" × 16" | " |
| 1 | " × 11" × 17" | " |
| 1 | " × 11" × 18" | " |

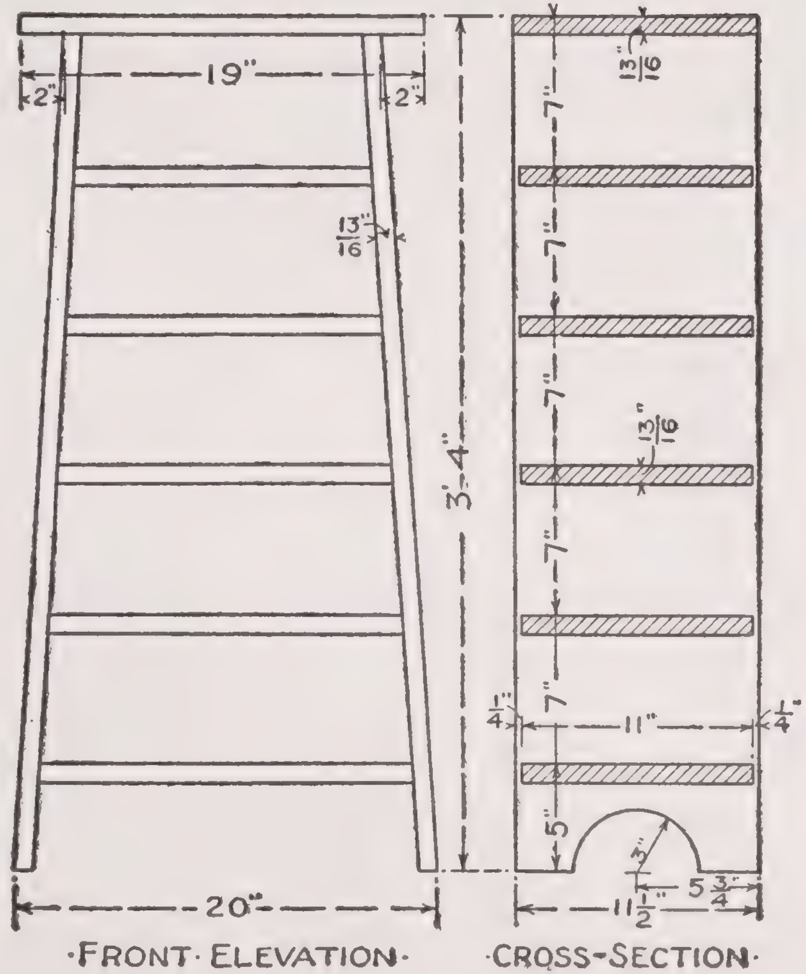



FIG. 131.—Details of Magazine-rack.

| LIST · OF · MATERIAL · | | |
|---|---|---|
| PIECES | DIMENSIONS | PARTS |
| 2 | 13/16" × 11½" × 2'-10" | ENDS |
| 1 | " × 7¾" × 16 3/8" | SHELF |
| 1 | " × 8 3/8" × " | " |
| 1 | " × 9" × " | " |
| 1 | " × 9 5/8" × " | " |
| 1 | " × 10¼" × " | " |

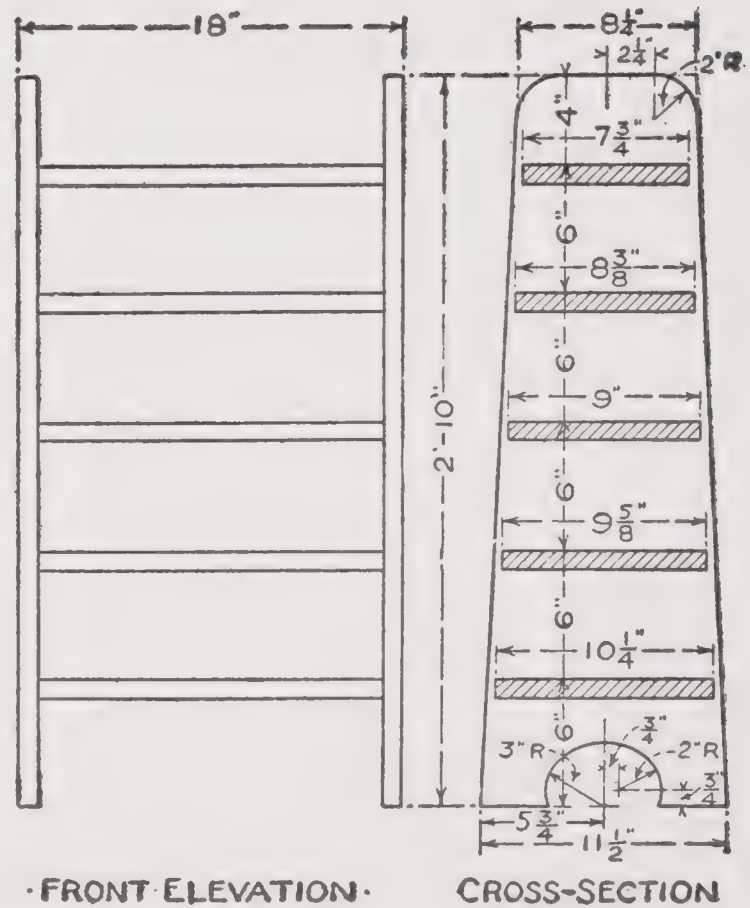



FIG. 132.—Details of Magazine-rack.

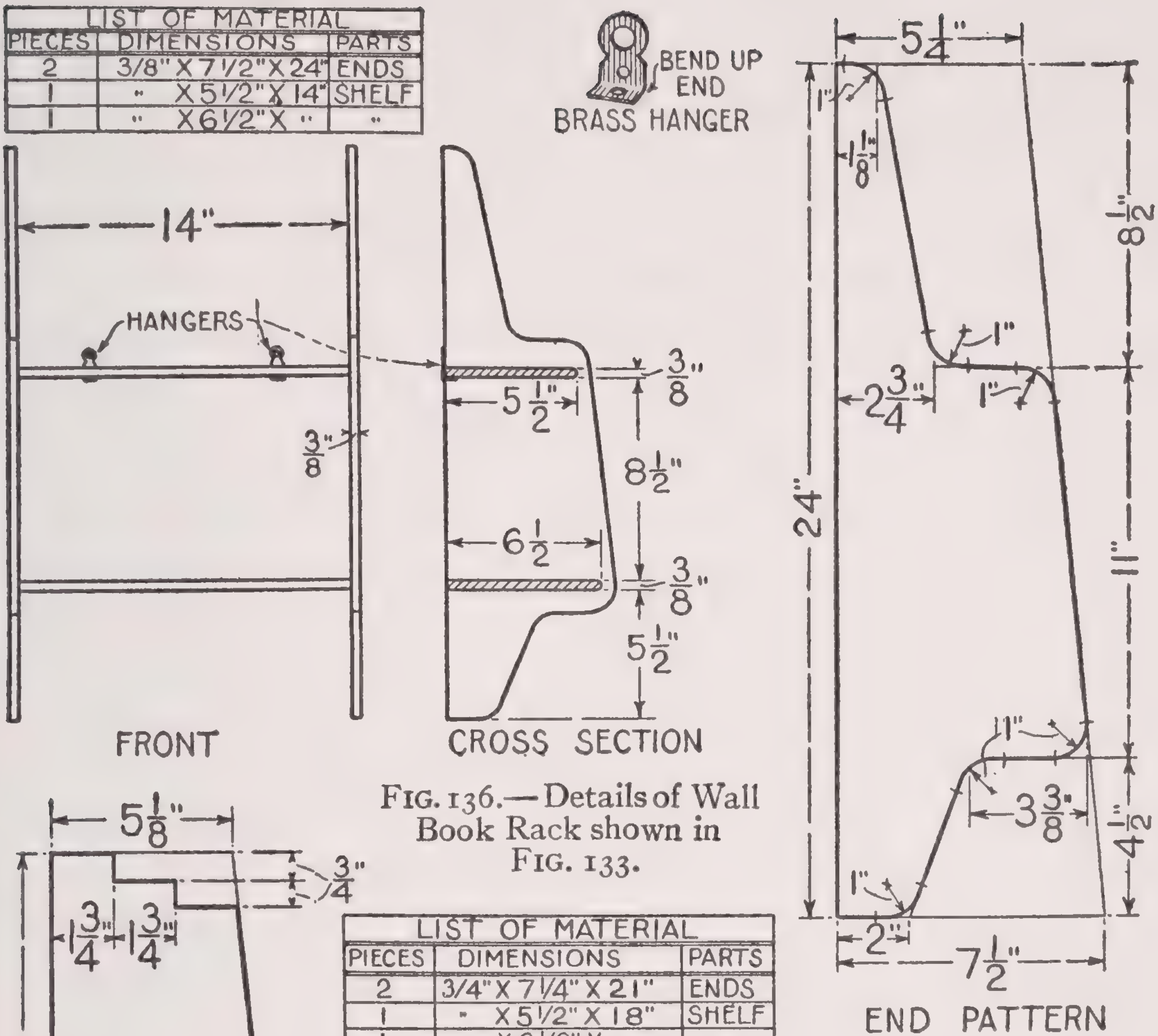
cross-section detail. Fasten the shelves to the end pieces with round-head screws.

As a result of the year's accumulation of new books, there is generally a shortage of shelves in the home bookcases. To provide for such an emergency, build one or more of the attractive

**Wall Racks** shown in Figs. 133 and 134. These racks are well adapted to the library, living-room, den, hallway, and bedroom. Individual book nooks, you might call them. Racks for yours schoolbooks, handicraft books, and other reference books.

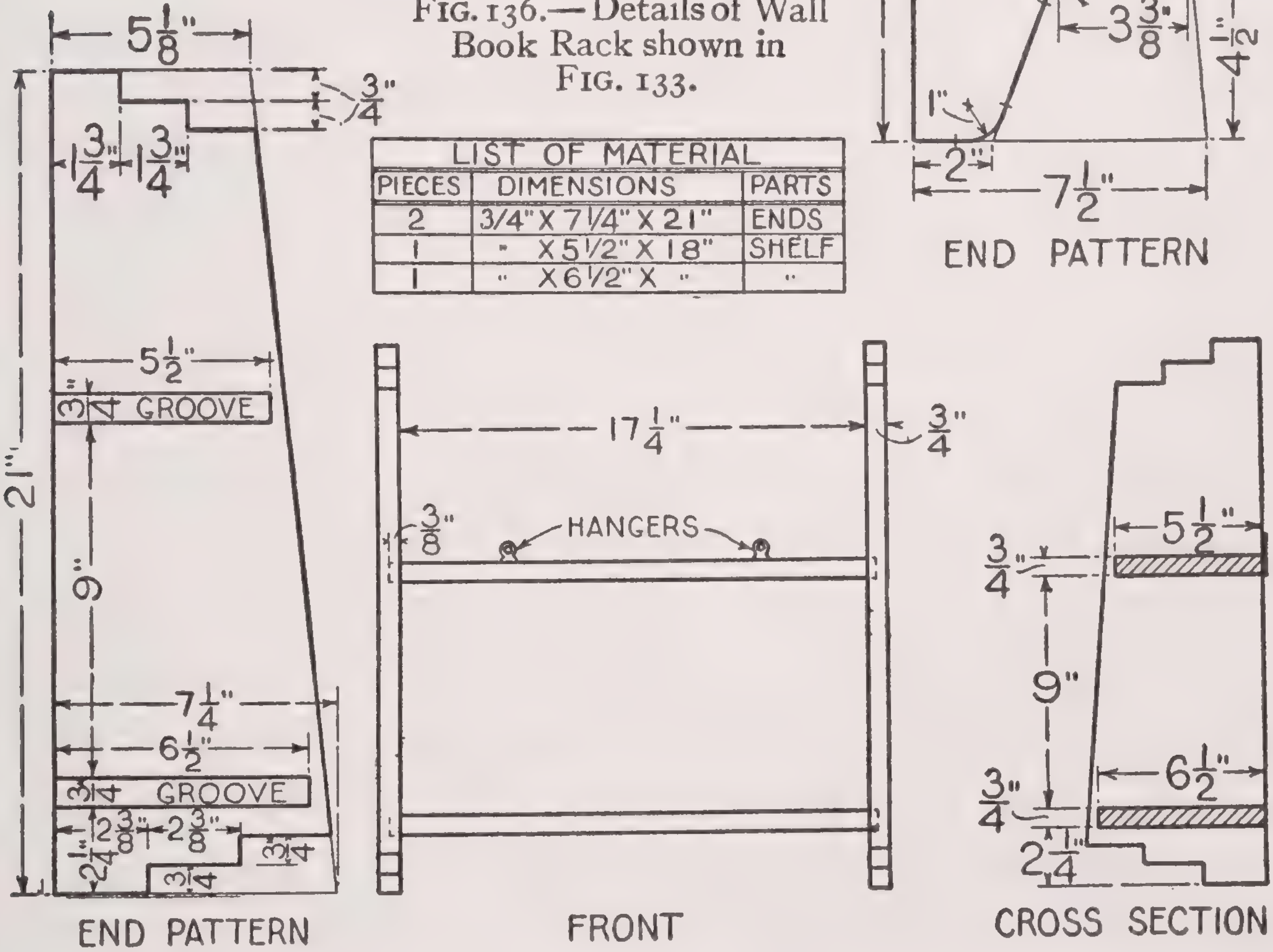
The smaller rack (Fig. 133) has a shelf 14 inches long for books, with a narrow shelf above it for a clock, a candlestick, or bric-a-brac. It is built of $\frac{3}{8}$-inch stock, and finished with enamel. You may find a box made of straight boards free from knots and defects that you can work up into pieces of the sizes required. If you must buy material, get $\frac{3}{8}$-inch plywood.

Figure 136 shows a front elevation and cross section of the rack; also a pattern of the end-pieces. Lay out the pattern upon a piece of cardboard, following closely the given dimensions. When you have drawn the straight lines, locate the centers for the curves, with a compass, and describe the arcs. Cut the paper pattern along the outline. Then mark out around it on the marking material. Saw out the two pieces with a coping-saw, or other fine-tooth saw, and smooth the




| PIECES | DIMENSIONS | PARTS |
|---|---|---|
| 2 | 3/8" X 7 1/2" X 24" | ENDS |
| 1 | " X 5 1/2" X 14" | SHELF |
| 1 | " X 6 1/2" X " | " |

FIG. 136.—Details of Wall Book Rack shown in FIG. 133.




| PIECES | DIMENSIONS | PARTS |
|---|---|---|
| 2 | 3/4" X 7 1/4" X 21" | ENDS |
| 1 | " X 5 1/2" X 18" | SHELF |
| 1 | " X 6 1/2" X " | " |

FIG. 137.—Details of Wall Book Rack shown in Fig. 134.

edges with sandpaper. A half-round wood-rasp (Fig. 33) will be handy for trimming up the curves. Lay out and cut the two shelves of the given dimensions, and round the front edge of each, as shown.

Use glue and finishing-nails for assembling the rack. Mark off the positions for the shelves upon the end-pieces, and carry the lines around the edge and outer surface of the pieces, to locate the nailing range. Drive the nails straight, and set the heads below the surface in preparation for puttying.

When you have assembled the rack, sandpaper all surfaces, and putty the nail holes. Then finish with two or three coats of enamel or lacquer, rubbing the surfaces lightly with sandpaper, between coats to remove roughness. Buy a pair of brass hangers at the hardware store, bend up the lower ends as shown in the detail and screw to the back edge of the upper shelf.

**The Larger Wall Rack**, shown in Fig. 134 is built of $\frac{3}{4}$-inch stock. Figure 137 shows a front elevation, cross section, and end pattern.

The end-pieces are easy to lay out and cut, because their lines are straight. Saw close to the lines, and be careful when cutting the notches not to split or splinter the edges. A fine-toothed saw should be used for cutting the notches, and a chisel or wood-rasp, or both, for trimming them smooth. Use a piece of No. 0 sandpaper wrapped around a square block of wood for a final

smoothing of edges. It makes a stronger job to groove, or dado, the end-pieces to receive the shelf ends. But you can substitute butt joints, if you want to. Positions for the grooves are given upon the pattern. Cut them $\frac{3}{8}$ inch deep. The way to lay out and cut grooves is described and illustrated in Chapter III.

The length and the widths of the shelves are given in Fig. 137. Notice that $\frac{3}{8}$ inch is allowed on each end for letting into the end pieces. With a nice job of grooving, the shelves will drive in snugly. Use glue and finishing-nails in assembling.

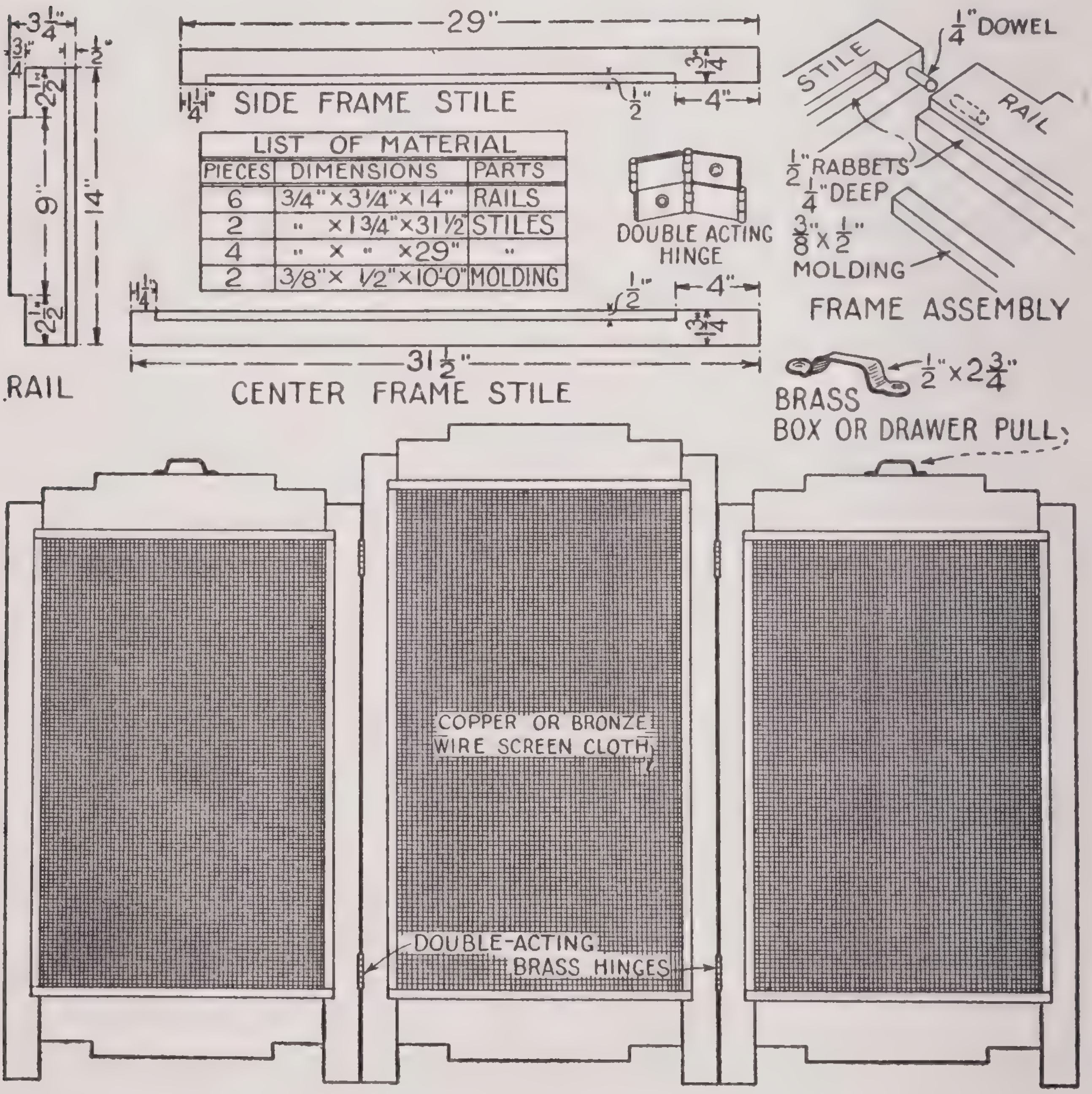
In the final sanding of surfaces, round all edges slightly. When the finish has been applied, attach a pair of brass hangers. Let the hangers into the back edge of the top shelf.

**The Fireplace Screen** in Fig. 135 is just the thing for your home living-room. Besides the material listed in Fig. 138, you will need 4 lineal feet of 28-inch copper or bronze screen-wire for covering the frames, double-pointed tacks, two pairs of 2-by-2-inch brass double-acting hinges, a pair of brass drawer-pulls, finishing-nails, brads, heat-resisting cement, and radiator bronze powder, varnish, and turpentine.

You will see by the details that the outer frames are alike, and that the center frame is $2\frac{1}{2}$ inches higher. The only change in dimensions of the two sizes of frames is in the length of the side stiles.

Rip the stiles and rails to the given sizes. Then

gauge a line ½ inch from the inner edge of one face of each piece, to locate the rabbets for the screen-wire covering. Notice that while the rabbets run from end to end of the rails, they stop 1¼ inches from the top of the stiles and 4 inches from the bottom. It is no trick to cut the rabbets with a chisel. Read




LIST OF MATERIAL

| PIECES | DIMENSIONS | PARTS |
|---|---|---|
| 6 | 3/4" x 3 1/4" x 14" | RAILS |
| 2 | " x 1 3/4" x 31 1/2" | STILES |
| 4 | " x " x 29" | " |
| 2 | 3/8" x 1/2" x 10'-0" | MOLDING |

FIG. 138.—Details of Fireplace Screen shown in Fig. 135.

the instructions in Chapter III. Make the depth $\frac{1}{4}$ inch.

Finishing-nails alone may be used for joining the frame corners, but the addition of dowels will make a stronger job. Dowel joints are described in Chapter III. Ordinary glue will be of little permanent value, because of the temperature to which the screen will be subjected, but there are heat-resistant liquid cements which will serve the purpose. In assembling, make certain that corners are right angles.

Cut the screen-wire to fit in the rabbets. Tack one selvage, then pull the opposite edge taut and tack it, then the other two edges. When you have tacked the wire to the frames, cut the square rabbet molding strips of the correct lengths and brad them in place.

Locate the hinges $4\frac{1}{2}$ inches from the center frame stile ends. Cut away the stile edges enough to let in the thickness of a single flap of the hinges. Fasten the drawer-pull handles to the center of the top of the end frames.

Remove the hinges and handles before finishing. Set nail and brad heads, and sandpaper all surfaces. Also, rub down all edges to remove their sharpness. Then apply a coat of shellac, and rub down lightly with fine sandpaper. For the finish, mix radiator bronze powder with varnish, and thin with turpentine to the consistency of paint. One coat over the shellac under-coat will be sufficient. An antique finish may be produced by

stippling the bronze coat with an antique or dark-green bronze.

**A Pup Door-stop** like that shown in Fig. 139 will guard your door and keep it from slamming. It is a gadget that will be admired by all who enter your home. Details of the parts and assembly are shown in Figs. 143 and 144.

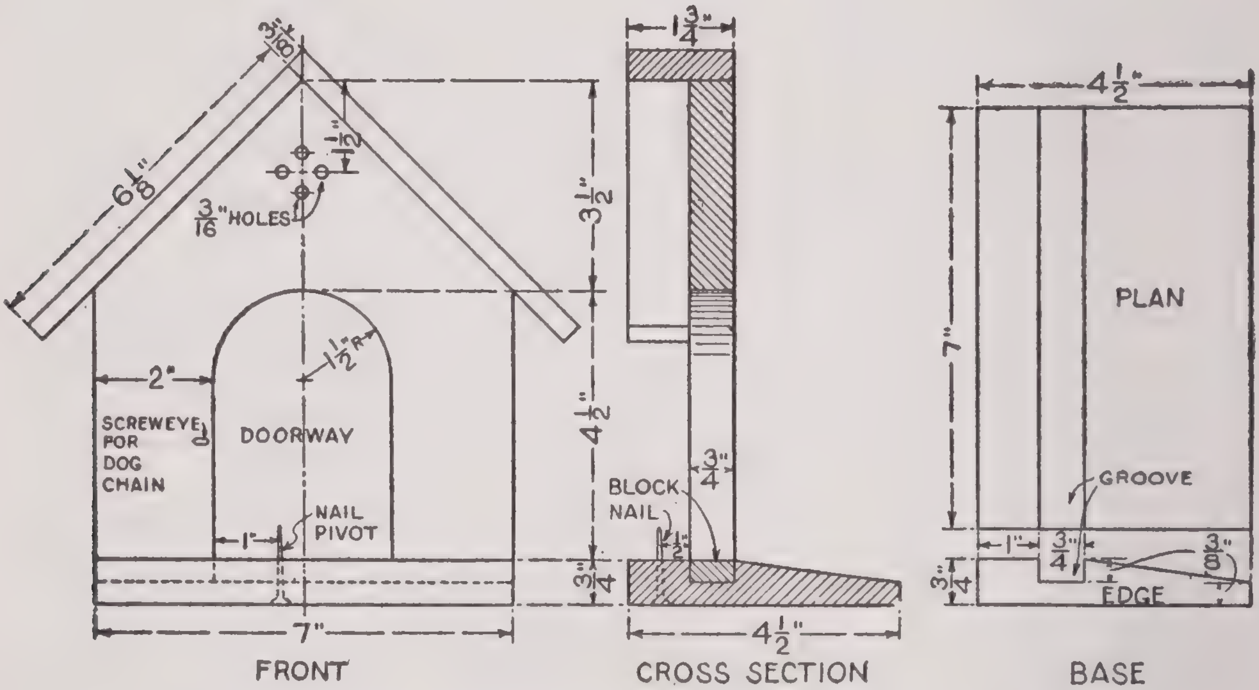



Fig. 143.—Details of Pup Door-Stop shown in Fig. 139.

The front of the kennel and the base block are of $\frac{3}{4}$-inch stock, the roof is of $\frac{3}{8}$-inch stock, and the dog is of $\frac{3}{4}$-inch stock. Lay out the front and base pieces by the given dimensions. Cut the doorway with a jig-saw or coping-saw. Bore the four $\frac{3}{16}$-inch ventilation holes in the gable in a square pattern. Groove the base-board for the kennel front to fit in. Run this groove from end to end, and then cut a block to fit in at the doorway

FIG. 141.—A Step Stool.

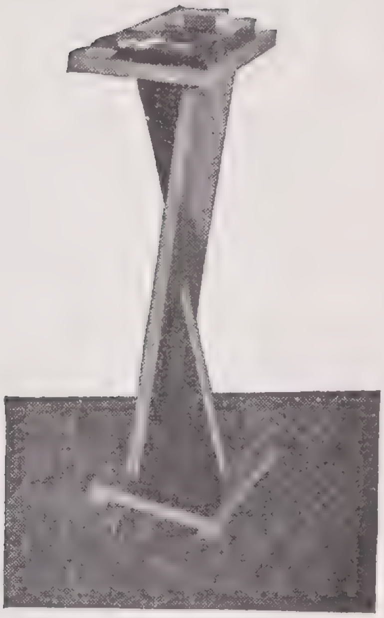


FIG. 142.—A Smoker's Stand.

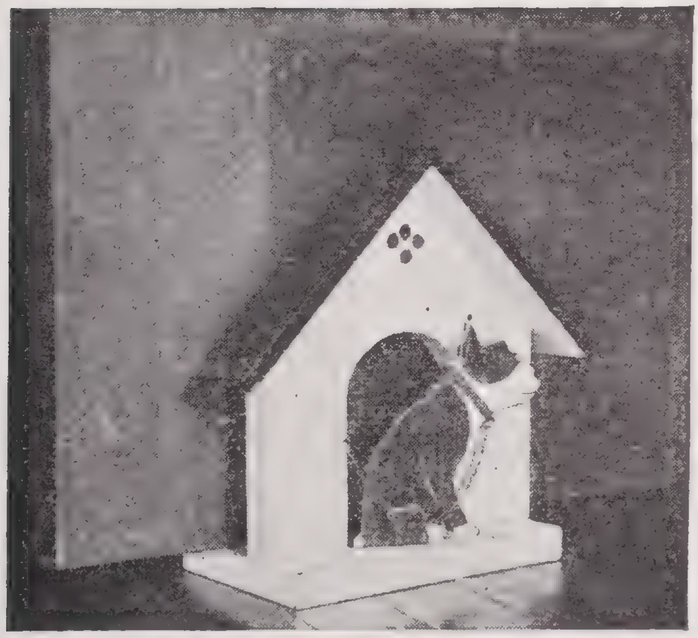


FIG. 139.—A Pup Door-Stop.

FIG. 140.—A Waste Basket.

threshold, or cut it only as far as the doorway. Cut one roof-board $\frac{3}{8}$-inch wider than the other, to allow for its overlapping.

Assemble the kennel with glue and finishing-nails, setting the nail heads and puttying the holes. Apply

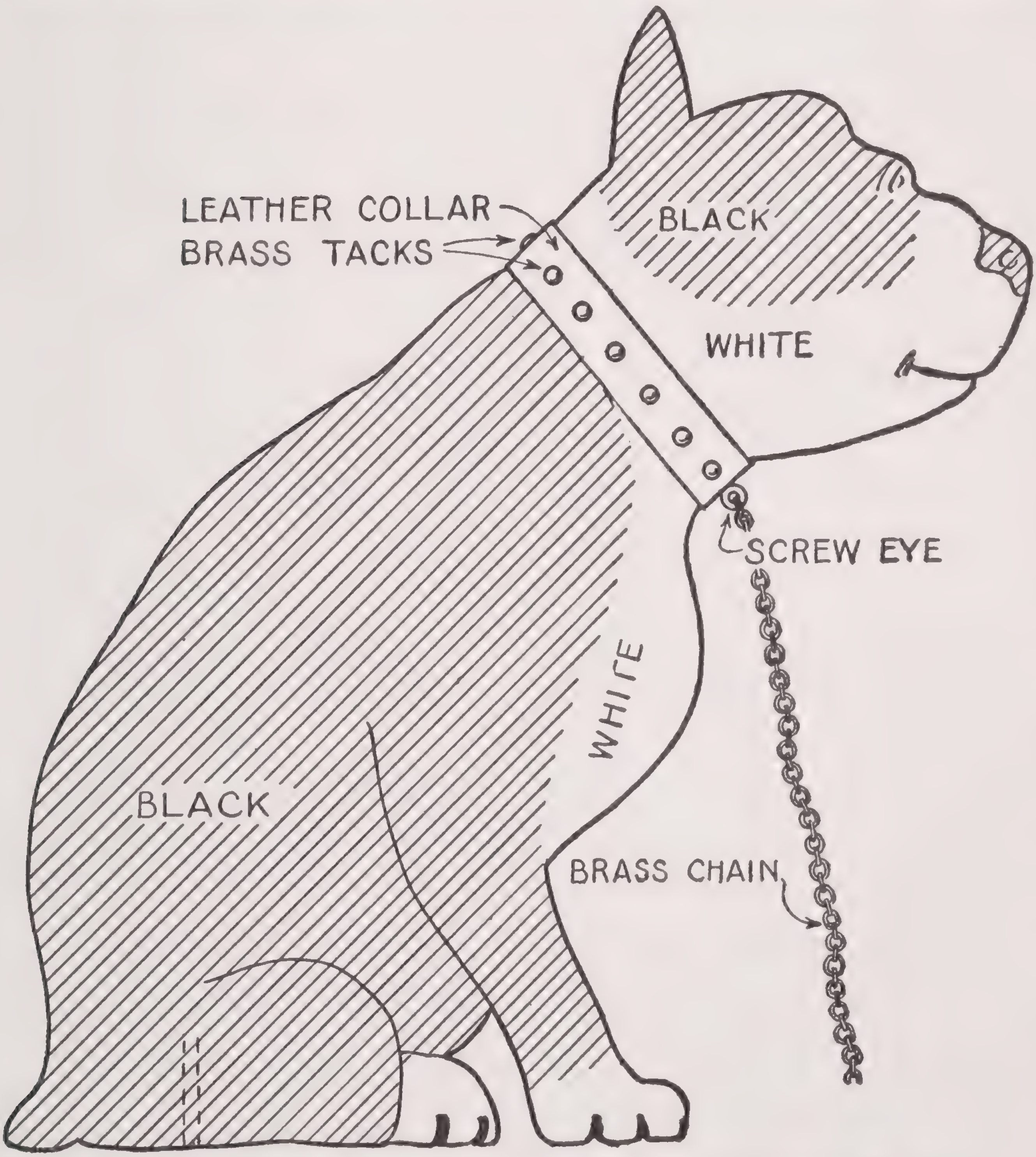



FIG. 144.—Full size pattern of Pup for Door-Stop shown in Fig. 139.

two coats of white enamel to all surfaces. Then paint the roof red.

A full-size pattern for the bull pup is shown in Fig. 144. Make a tracing of it on transparent paper, and reproduce this on a piece of board. Saw on the outline, then finish up the edges with a file and smooth with sandpaper.

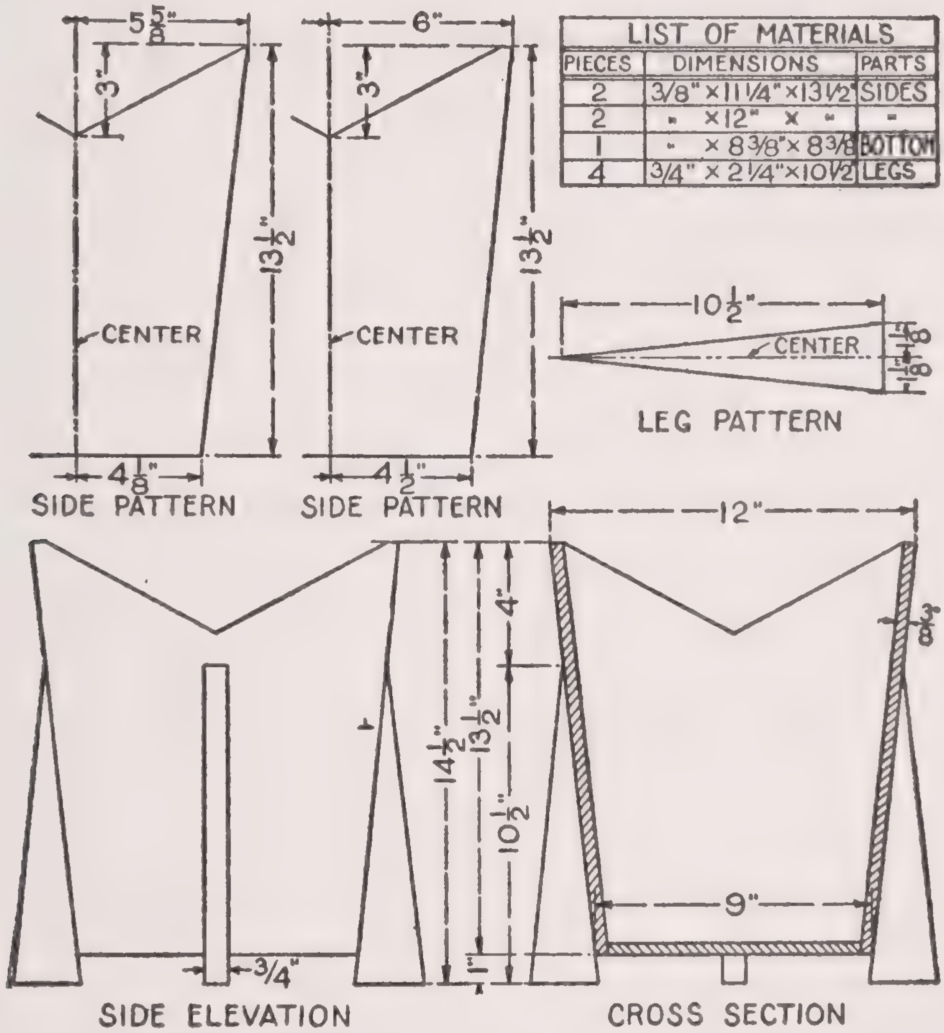
Finish the pup with two all-over coats of white enamel. Then paint the black portions of the head and body with black enamel, and indicate the eyes, nostrils, mouth, and legs with white and black paint applied with a fine brush. Make a collar of a narrow strip of leather, enamelled red, and fasten it with a row of round-headed brass tacks. The tacks will form studs. Screw a small brass screw-eye into the front of the collar for a ring.

Pivot the dog in the position shown with a finishing-nail driven through the base of the kennel into a $\frac{1}{16}$-inch hole drilled in the pup block. The nail pivot will make it possible to swing the pup into any position wanted. Screw a brass screw-eye into the front of the kennel, and fasten a short length of brass chain to it and to the dog's collar.

**A Waste-Basket** like that in Fig. 140 will be liked because of its unique lines. Finished in green or red enamel, it will give a pleasing touch of color to a living-room, library, den, or bedroom.

The sides and bottom of the waste-basket are made

of $\frac{3}{8}$-inch plywood. Basswood is excellent for the purpose. If you cannot get plywood, you may substitute a hard-surfaced wallboard for the sides. In that case, make the bottom of $\frac{3}{4}$-inch stuff and reinforce the corners




| PIECES | DIMENSIONS | PARTS |
|---|---|---|
| 2 | 3/8" × 11 1/4" × 13 1/2" | SIDES |
| 2 | " × 12" × " | " |
| 1 | " × 8 3/8" × 8 3/8" | BOTTOM |
| 4 | 3/4" × 2 1/4" × 10 1/2" | LEGS |

FIG. 145.—Details of Waste Basket shown in Fig. 140.

inside, with strips $\frac{1}{2}$ inch square to give the basket rigidity.

Lay out the side-pieces by the half patterns in Fig. 145. A sure-fire method of getting a symmetrical job is to make a cardboard templet of one-half of the sides, then reproduce the templet outlines to the left and to the right of center-lines.

When you have ripped out the four sides, and dressed their edges, assemble them with glue and finishing-nails. Make certain that the corners are square. Then take the measurements for the bottom board, from the assembled sides, lay out the piece, cut it, and bevel its edges to the angle of the sides. Fasten the bottom board with glue and finishing-nails, flush with the bottom edges of the sides.

The leg strips have the same pitch as the basket sides. A pattern is given in Fig. 145. Cut the pieces out of stock $\frac{3}{4}$-inch thick. Glue and nail them to the center of the sides, with the lower end projecting 1 inch.

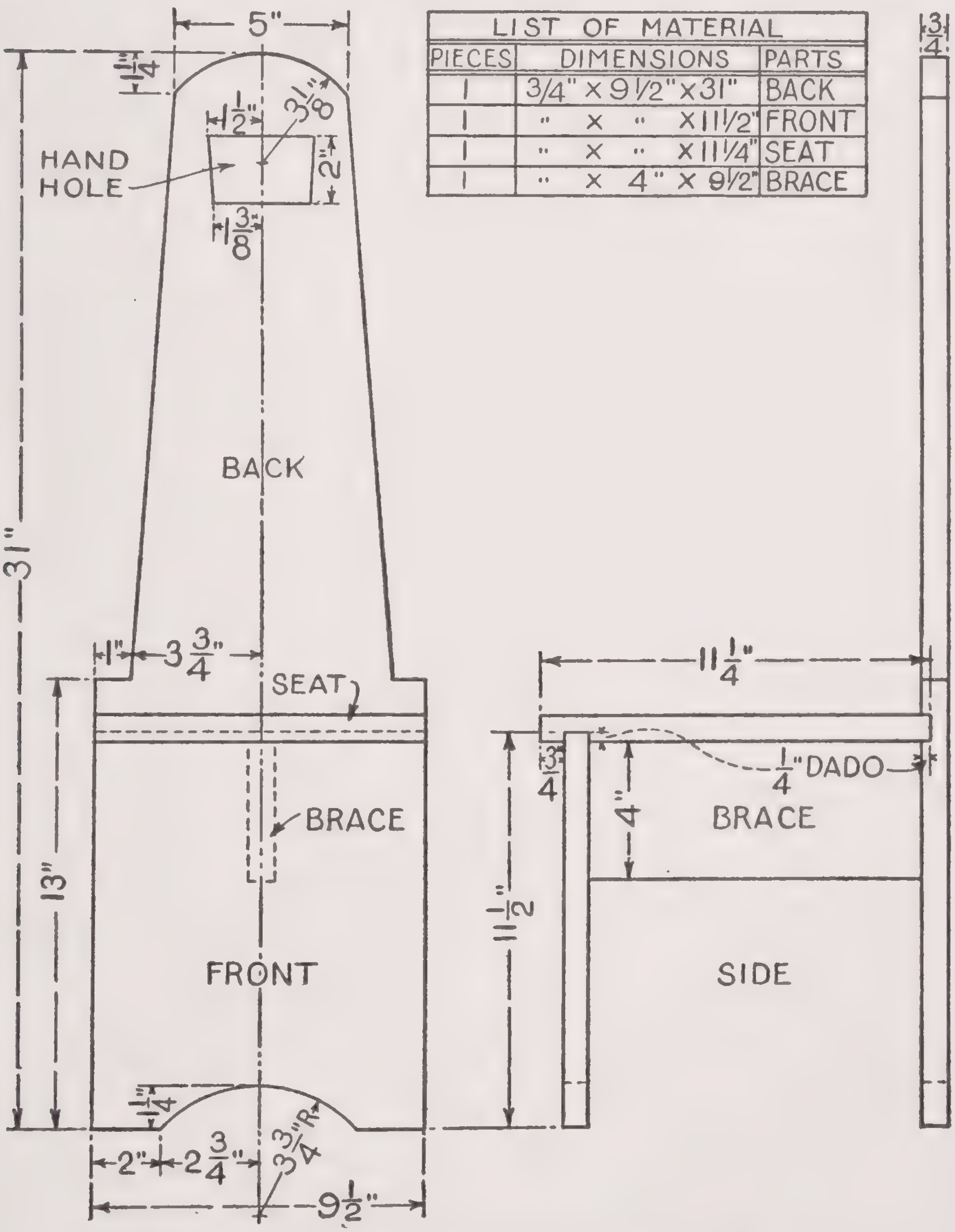
Set all nail-heads, trim off the top edges and corners if necessary, putty nail-holes and joints, and sand all surfaces. Then finish with an under-coat of shellac and one or two coats of enamel. Rub lightly with sand-paper between coats.

**The Step-Stool** shown in Fig. 141 is a little brother to the step-ladder. After Mother has used it for a while, she will wonder how she ever got along without it. Its service will be extended to every room in the house, to the garden, and to the clothes-drying yard. It may be looked upon as first-aid equipment, since it will discourage standing in chairs, and possibly prevent the breaking of bones.

Details of the step-stool are shown in Fig. 146. A 10-inch board 6 feet long is sufficient for the job. Twelve-inch stuff will make a wider step and seat,

but the advantages of a small lightweight stool are obvious.

Starting with the back, scribe a center line along the working material, and lay off the height measurements along the line. Square lines across the board at these




| LIST OF MATERIAL | | |
|---|---|---|
| PIECES | DIMENSIONS | PARTS |
| 1 | 3/4" x 9 1/2" x 31" | BACK |
| 1 | " x " x 11 1/2" | FRONT |
| 1 | " x " x 11 1/4" | SEAT |
| 1 | " x 4" x 9 1/2" | BRACE |

FIG. 146.—Details of Step Stool shown in Fig. 141.

points, and lay off the width measurements upon the lines, and draw the outline. Describe the end arcs. Draw the side lines of the hand-hole parallel to the opposite tapering edges. Use a jig-saw or coping-saw for cutting the curves and hand-hole, and true up the edges with a wood-rasp, chisel, and plane. Cut a groove or dado, $\frac{1}{4}$ inch deep in the back for the seat to fit in.

The front leg, seat, and brace have square corners. Cut a groove in the under side of the seat for the front leg to fit in.

Assemble the parts with glue and finishing-nails.

A coat of shellac and another of varnish will make a neat and lasting job. But a coat of colored enamel over the shellac will be more attractive.

**The Smoker's Stand** in Fig. 142 will be liked for its oddity of design, and for its bright two-color finish. Build one for the living-room or for Father's den. It is a piece of furniture of few parts, as you will see by the detail diagrams in Fig. 147. There is more work to the assembly because of the angular parts, but with each piece cut correctly by the patterns, you will have no difficulty. Since the design suggests an enamel or lacquer finish, use basswood, whitewood, pine, or fir for the parts.

You will see by Fig. 147 that the top and base are alike, also the triangular brackets. When you have cut the upright, plane a $\frac{1}{8}$-inch bevel on each end, as indicated.

Begin the assembly by fastening the top and base boards to the upright. Scribe a line parallel to and $1\frac{1}{2}$ inches inside of the edges of the top and base pieces, as indicated, to locate the position for the upright. Check up to make certain that the top lines up with the base. If it does not, trim off the ends of the upright

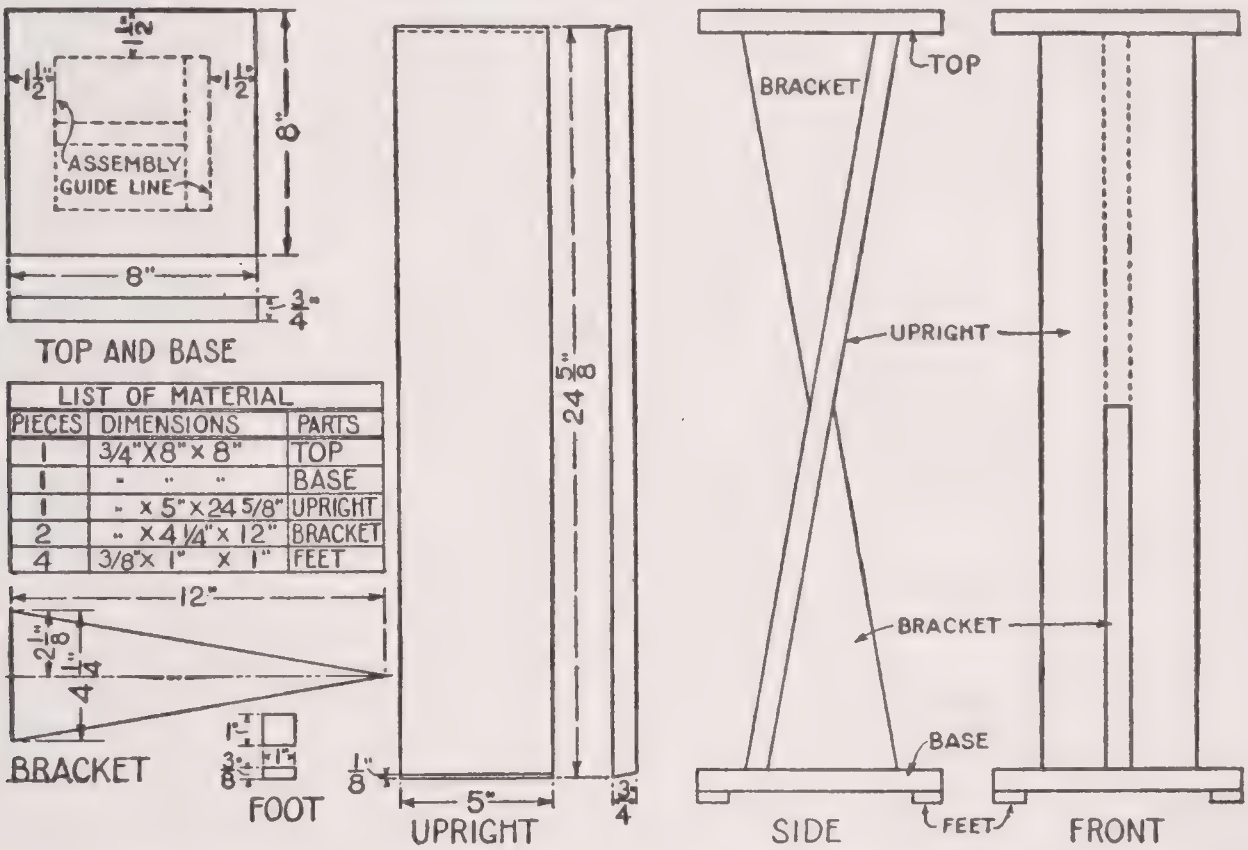



FIG. 147.—Details of Smoker's Stand shown in Fig. 142.

until the necessary correction has been made. Set the brackets in place, and glue and nail them to the upright, top, and base.

With the assembly completed, the nail-heads set, the nail-holes and joints puttied, and all surfaces sandpapered smooth, apply a coat of shellac. Then sandpaper lightly, and apply one or two coats of enamel. When the enamel has dried, trim the edges with enamel

of a contrasting color. The model in the photograph was finished in orange, with the edges trimmed in silver. Black or blue trimmings would be equally effective.

**An Electric Lamp** with a wooden stand and base is very simple to make. Figure 148 shows an attractive desk or table lamp, which may be fitted with one of the perforated brass lamp-shades described in Chapter XIII. The stand is made in four pieces (*A*, *B*, *C*, and *D*, Fig. 148). After cutting these to the dimensions given, and beveling pieces *B* and *C* as shown, bore a $\frac{3}{8}$-inch hole through the center of each. As the hole through *A* will be too long for your bit, bore it halfway through from each end, being careful to bore perfectly straight so the holes will meet at the center. Also bore a hole of the same diameter through the center of one side of base piece *C*, as shown, to meet the vertical hole. These holes are made for the electric wires to run through. If

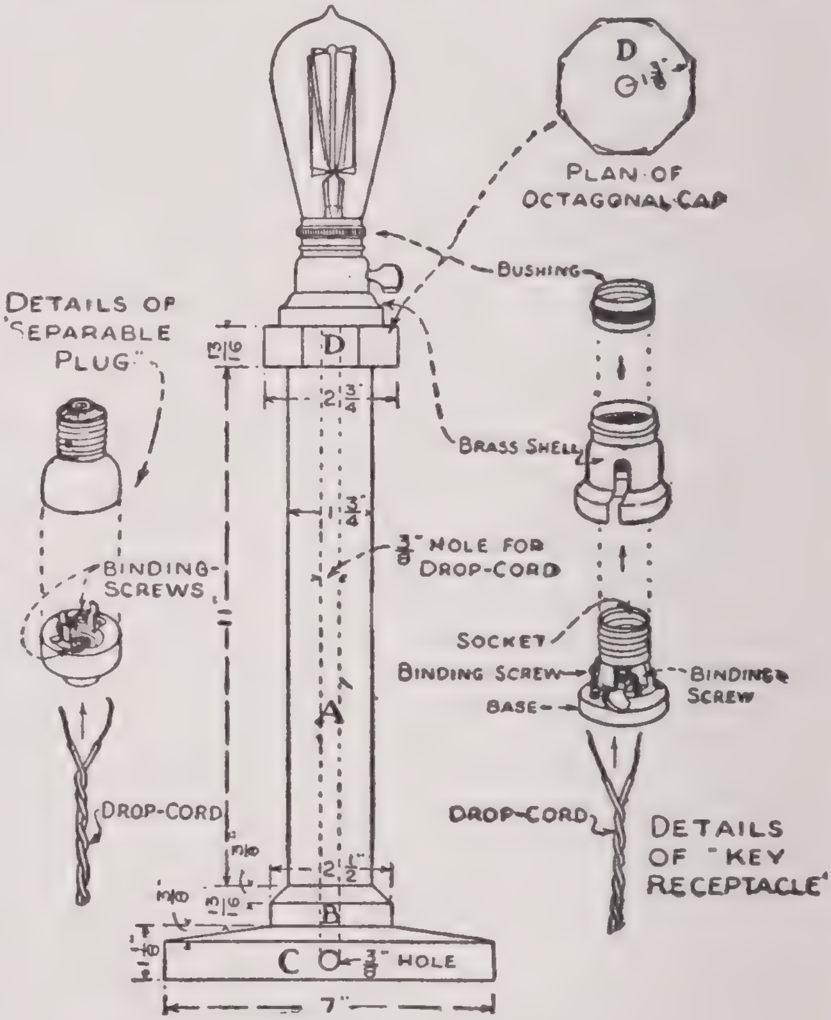
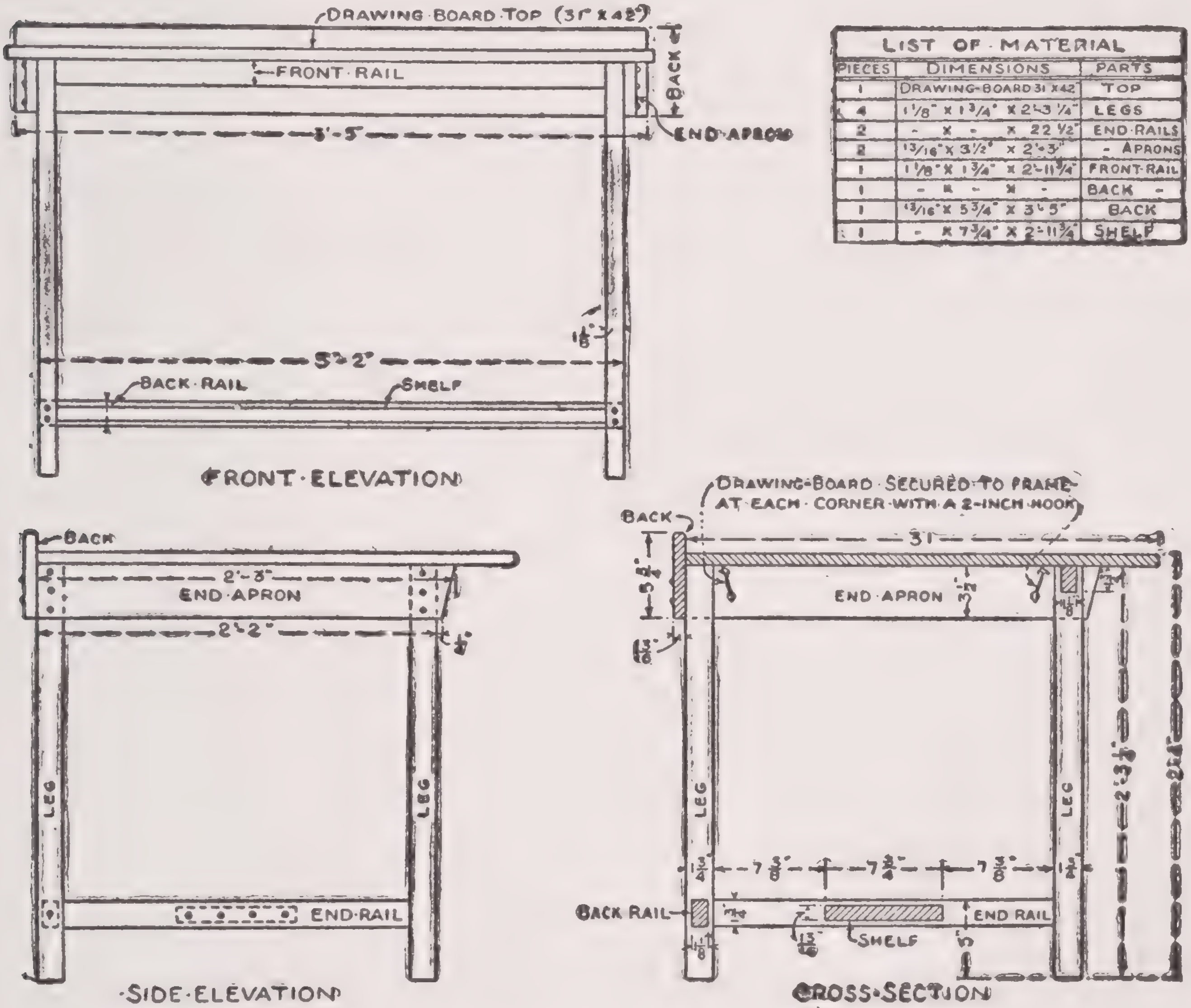



FIG. 148.—Details of Electric Lamp.

you want to save the work of making the long hole, bore a hole through cap *D*, and in the end of upright *A* to a depth of 1 inch. Then bore a hole in one side of *A* just below *D* to meet this hole.




| LIST OF·MATERIAL | | |
|---|---|---|
| PIECES | DIMENSIONS | PARTS |
| 1 | DRAWING-BOARD 31"x42" | TOP |
| 4 | 1 1/8" x 1 3/4" x 2'-3 1/4" | LEGS |
| 2 | - x - x 22 1/2" | END·RAILS |
| 2 | 13/16" x 3 1/2" x 2'-3" | - APRONS |
| 1 | 1 1/8" x 1 3/4" x 2'-11 3/4" | FRONT·RAIL |
| 1 | - x - x - | BACK - |
| 1 | 13/16" x 5 3/4" x 3'-5" | BACK |
| 1 | - x 7 3/4" x 2'-11 3/4" | SHELF |

FIG. 149. —Details of Drafting Table shown opposite page 86.

**Wiring the Lamp** requires no description. The lamp receptacle may be of the type shown in the diagram, or a regular lamp receptacle, with key or pull-chain.

Opposite page 86 is shown a view of

**A Drafting Table** the author has used in his home work-

room for a number of years. Probably not many of you boys will do enough drafting to require such a table for the purpose, but it also makes a splendid desk table, and for this reason working details for its construction are given in Fig. 149. The legs, aprons, back, rails, and lower shelf are screwed together, no mortising entering into the table's construction. A drawing-board was used for the table top, and it was fastened in place with hooks and screw-eyes, as shown. An excellent top can be made of plywood $\frac{3}{4}$-inch thick, or two pieces of $\frac{3}{8}$-inch plywood glued together. Basswood makes the best surface for drafting, and it is easy to get in $\frac{3}{8}$-inch plywood. Another plan is to make a glued-up top, and to place a drawing-board upon it when drafting.

**A Tilting Top** is a worth-while development in a drafting table. It makes it possible to adjust the drawing surface to a plane at right angles to your line of vision. Lawrence Brown of Roanoke, Virginia, has made such a device. First, he hinged the front edge of the table top to the table frame. Then he bought a pair of metal storm-sash adjusters, and screwed the hinged ends of the rods to the under side of the table top, and the adjustment plates to the ends of the table frame.

# CHAPTER VII

## HOME REPAIRS AND GADGETS

ACQUIRE a reputation for being handy, and opportunities to earn money will not be lacking. Neighbors will call upon you when this and that thingumajig needs repairs or a home-made gadget is wanted. You can win that reputation by servicing at home. For one thing, look to

**Leaking Faucets.** Sink and tub faucets are usually of the *Fuller faucet* type. Ordinarily, a new Fuller ball is all that is needed to stop a leak. Buy it at a hardware store. Shut off the water supply. Unscrew the faucet at the point indicated in Fig. 150. You will see that the Fuller ball projects, as shown in the cross-section. Unscrew the small nut on the pin end, and remove the metal cap, and the worn ball. Slip a new ball of correct size onto the pin with large end out. Replace the cap and nut. Then turn the handle lever to an angle of 45 degrees. This should draw the ball into the valve seat. If it does not, turn the nut until such adjustment is obtained.

An old faucet may require a new valve-stem packing,

a new stem or pin (Fig. 150). Buy these at a hardware store.

The *compression faucet* is of the lavatory type. The cross-section shows how the valve stem screws down until the end washer fits the seat. Unscrew the packing nut, remove the handle and valve stem, unscrew the washer screw, and replace the old washer with a new one.

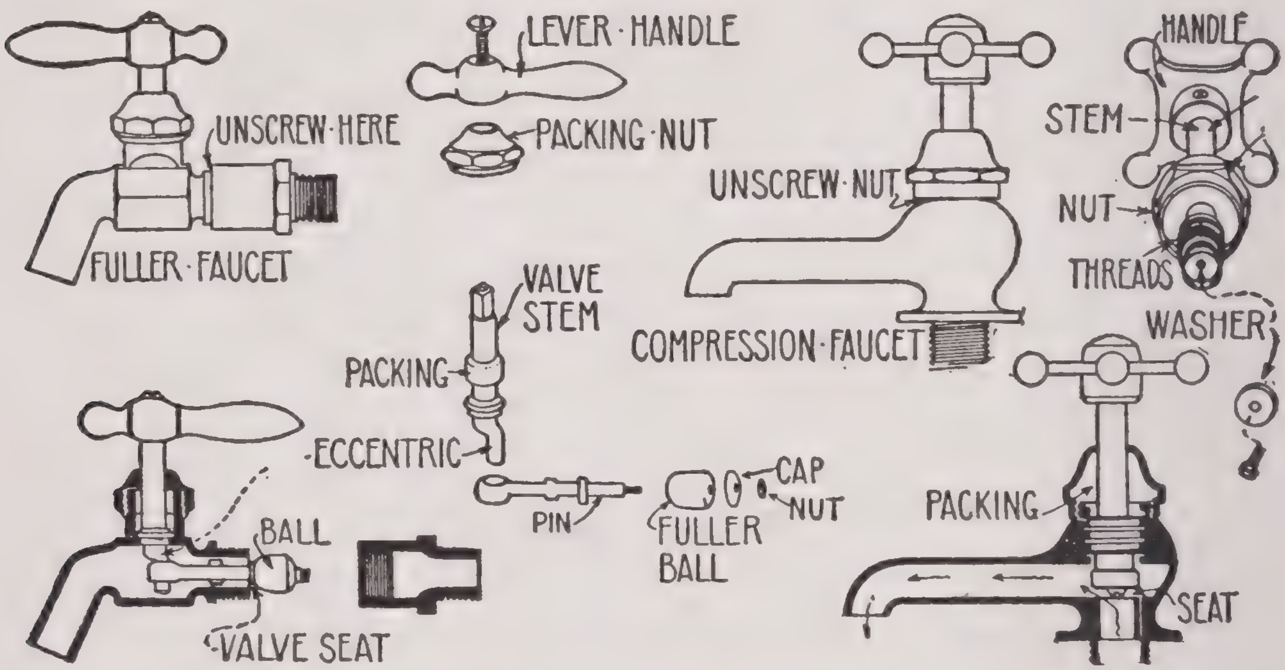



FIG. 150.—With a Handy Boy about the House there is no Excuse for Leaking Faucets.

**Door Locks** require attention when a key breaks off, when a latch or lock-spring breaks, when parts become rusty, and when a door is rehung so as to require a reversal of the latch.

To release a lock, remove one knob and draw out the spindle (Fig. 151). Remove the two screws from the selvage plate, and lift out the lock. A set-screw holds the lock cover. A detail shows the lock without its

cover. In oiling, apply sewing-machine oil, then rub it off dry.

The latch-plate often requires resetting, to bring about an alignment of latch and pocket. Unscrew the plate, and cut the door jam in the direction in which the plate must be shifted. Make new screw

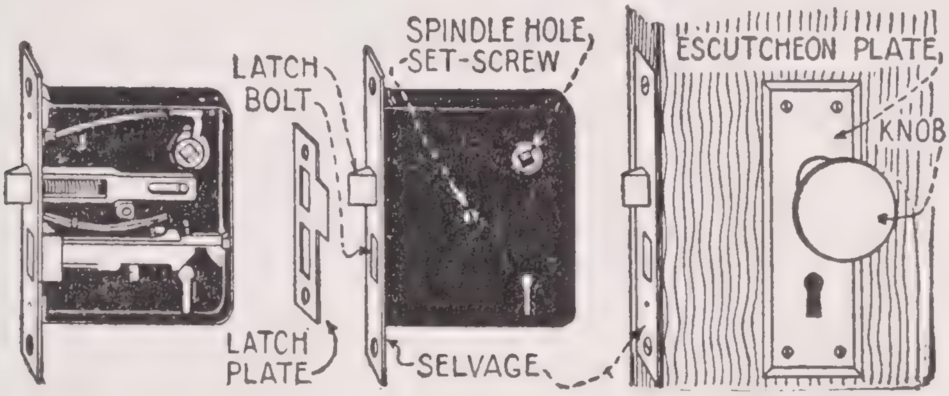



FIG. 151. — Door Locks often require Attention.

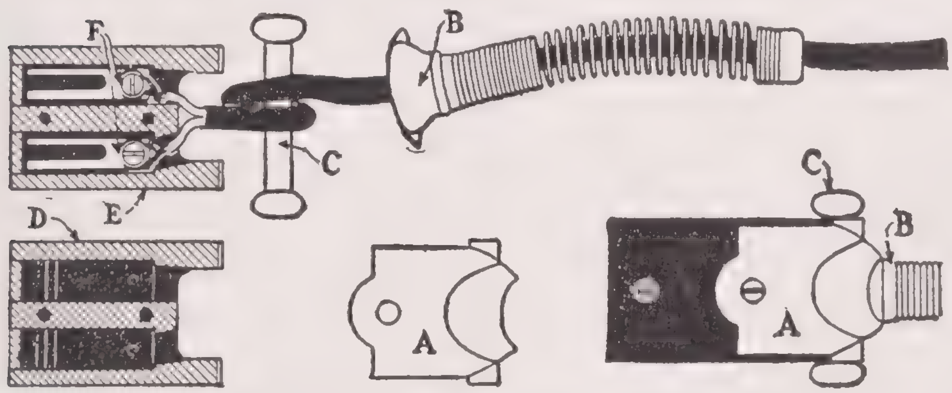



FIG. 152. — Electric Appliance Cords are easily repaired.

holes, and screw the plate in place. Glue a wooden chip into the space vacated by the plate.

**Electric Appliance Cords** are easily repaired, with parts obtained at the electric shop. Trouble usually develops at the plug, or at the attachment piece (Fig. 152), as a result of the breaking of wires. If the wires are broken, cut them of equal length, scrape bare the new ends, and make them fast to the binding posts.

**A Pot-cover Rack** such as shown in Fig. 153 provides the most satisfactory way of keeping these covers, as the one desired is always within convenient reach —which is never the case when they are piled up on a shelf or in a drawer.

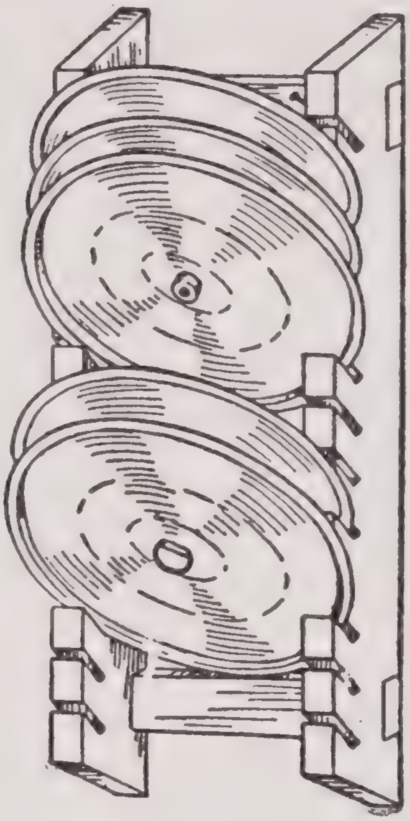


FIG. 153. — Pot-cover Rack.

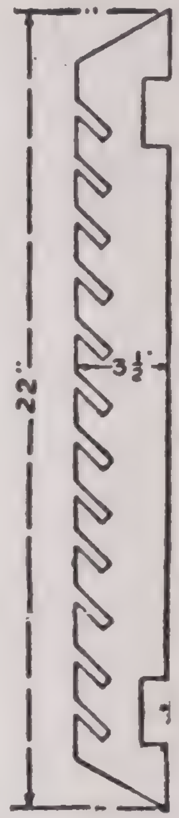



FIG. 154. — Pattern for Side Pieces.

Figure 154 shows the pattern for the side pieces of the rack. Space the slots as shown, then cut along the side lines of each slot with a saw and remove the wood with a chisel. Notch the back edges as shown, and cut the two connecting cross-pieces 8 inches long to fit in these notches. Nail or screw the cross-pieces in place, and bore a couple of holes through the upper one so the rack may be hung up on nails in the pantry.

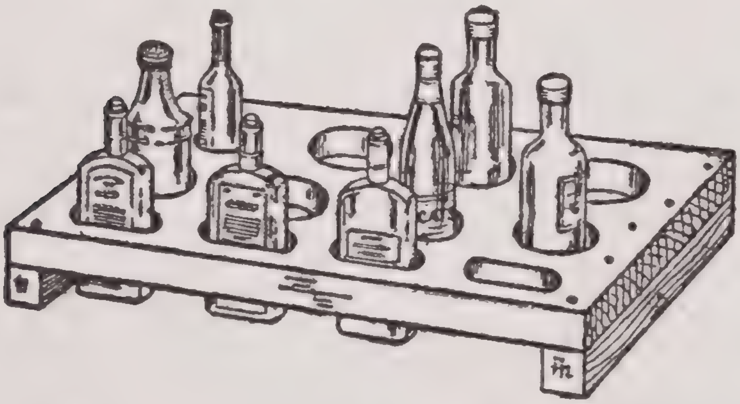


FIG. 155. — Pantry Shelf Bottle-rack.

**The Bottle-rack** shown in Fig. 155 is a contrivance which your mother will appreciate, as it will hold all

of her bottles of extracts, catsup, Worcestershire sauce, olive oil, etc., and prevent one bottle from knocking over several others when lifted out from behind them.

The rack is made out of a piece of board measuring 9 inches wide and 15 inches long, and the holes for the bottles are laid out and cut as shown in Fig. 156. After cutting the board and planing it up smooth and true, lay off along the edges the measurements given for the centers of the holes and square lines across the board at these points. The centers will be at the intersections of the lines. For the two rows of large holes describe circles $2\frac{1}{4}$ inches in diameter, and for the row of slots describe a circle 1 inch in diameter each side of the vertical center-lines with a center $\frac{3}{4}$ inch away from the lines, as shown.

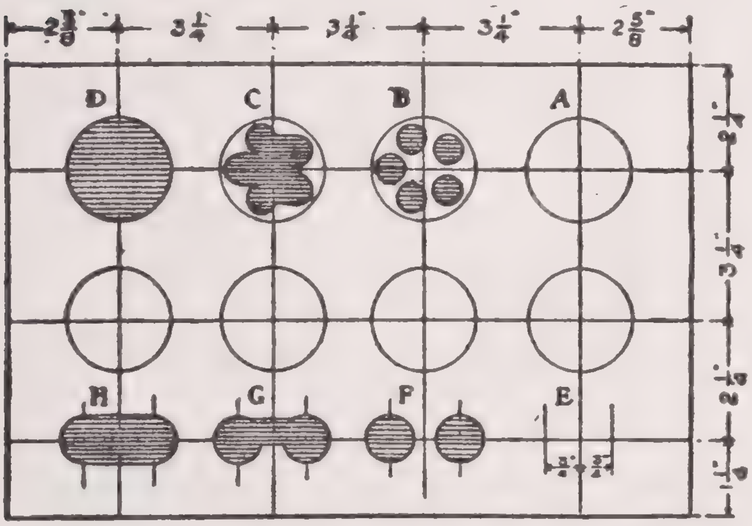


FIG. 156. — Plan of Bottle-rack.
(Showing the four steps in cutting holes larger than your largest auger-bit will bore, and in cutting slots.)

**Cutting Large Holes.** Unless you have an expansive-bit (Fig. 24, page 21), which can be set to the proper radius, you will have to bore a number of small holes inside of the large circles and then finish the cutting with a chisel. In the first row of holes on the diagram (Fig. 156), *A* shows the first step—describing the circle; *B* the second step—boring a ring of holes inside of the circle;

*C* the third step—splitting out the wood between the holes; and *D* the fourth step—trimming up the hole to the circle with a chisel. The diagram also shows the four steps required to cut the slots. *E* shows the centers marked off each side of the center lines, *F* the two 1-inch holes bored at these centers, *G* how the wood between the holes is split out, and *H* how the slot is finally trimmed up. Nail a cleat to the under side of each end of the board.

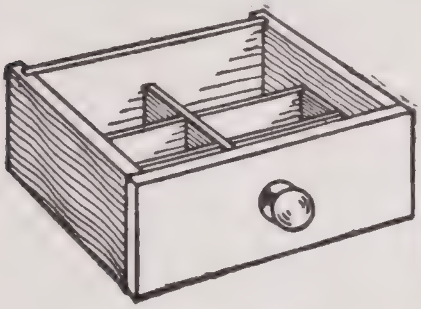


FIG. 157.

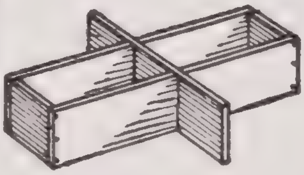


FIG. 158.

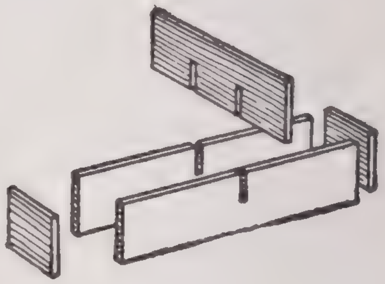


FIG. 159.

FIG. 157. — Partitions Bring Order to the Hosiery Drawer.
FIG. 158. — Make the Partitions Removable.
FIG. 159. — Halve the Crossing Partitions in this Way.

**Drawer Partitions** bring order to the dresser hosiery drawer, table-silver drawer, and pantry-cabinet drawers. Figure 157 shows a drawer with six compartments. The partitions are made removable (Fig. 158). Make them of grocery-box boards or plywood $\frac{3}{8}$ inch thick. Figure 159 shows how to join the crossing pieces with halved joints. Make the joints as instructed on page 60. Round off the top edges of the partitions. Fasten with brads and glue. Finish to match the inside of the drawer.

**Weather Strips** are easy to attach. There are many kinds. Figure 160 shows how to apply the wooden strip with felt inlay type. You will need a coping-saw, tack hammer and $\frac{3}{4}$-inch brads for the job. Notice by the diagram that the lower window sash is stripped upon the inside, the upper sash upon the outside, with the

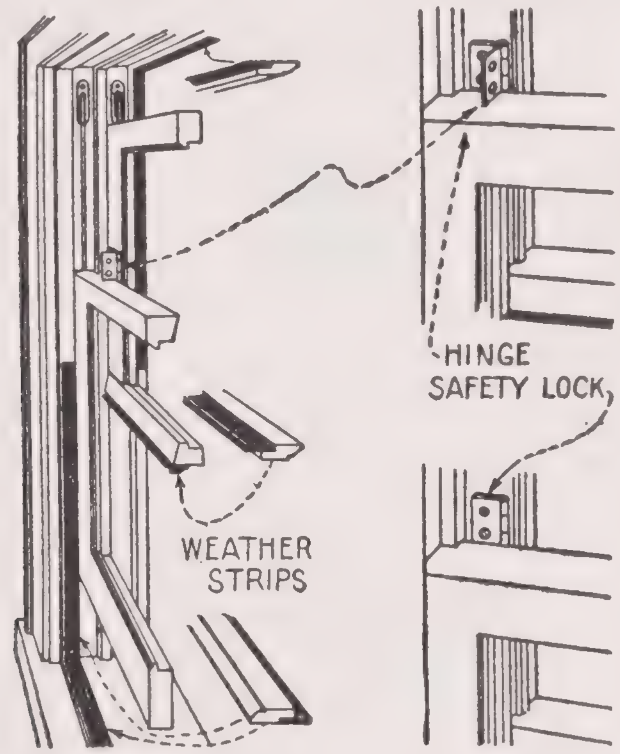



FIG. 161.

FIG. 160. FIG. 162.

FIG. 160. — You can do a Good Job of Weather-Stripping Doors and Windows.
FIGS. 161 and 162. — There is no better Safety Lock than a Hinge, for Double-Hung Windows.

strips placed so that the felt makes close contact with the sash. Metal weatherstrips are not difficult to put on. Printed directions can be had at a hardware store.

**Hinge Safety Locks** cannot be improved upon for double-hung windows (Figs. 161 and 162). Screw one flap to the upper window sash at a point that will permit

raising the lower sash, yet not high enough to admit an intruder. When the free flap is turned at right angles (Fig. 161), the lower sash cannot be raised beyond that point. When it is folded (Fig. 162) either sash may be opened.

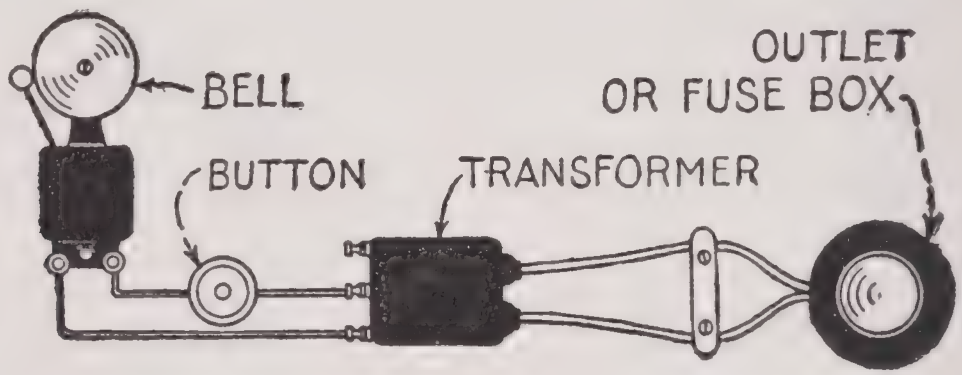



FIG. 163. — A Bell Transformer is easily installed.

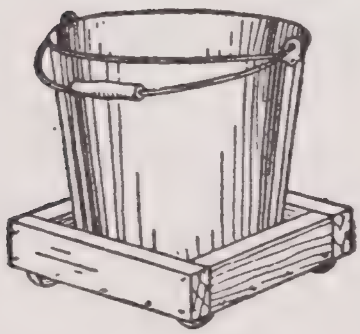


FIG. 164. — Scrub-pail Platform.

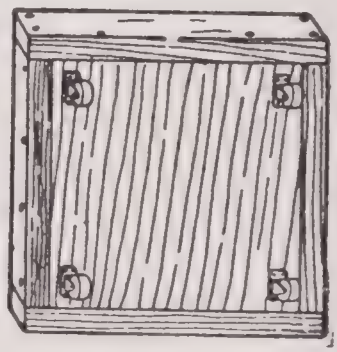


FIG. 165. — Bottom View of Platform.

**A Bell Transformer** ends battery cell replacements. If the house electric wiring is exposed, mount the transformer close to two wires. Switch off the current, scrape an inch of each wire bare of insulation, bare the transformer wire ends, and twist them tightly around the bared circuit wires. Solder the connections and tape with rubber and friction tape. If the wiring is in

conduit, tap an outlet box or fuse box. Figure 163 shows the hook-up.

**Other Bell Installations** may be needed in your home—a bell for the side door, one in the garage, and a buzzer between the dining-room and kitchen. You can do the work.

**A Scrub-pail Platform** on casters is convenient when scrubbing and mopping floors. Figures 164 and 165

FIG. 168. FIG. 167.

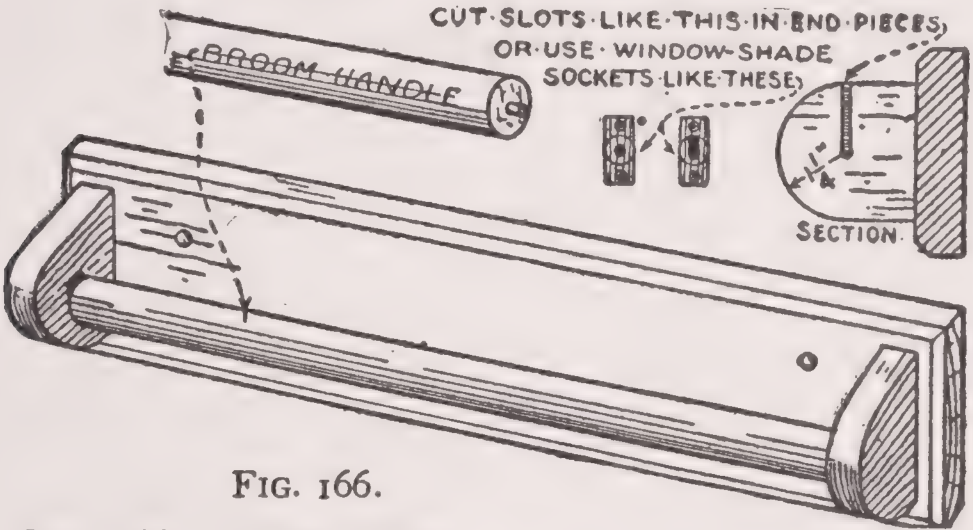



FIG. 166.

FIG. 166. — Towel-roller.
FIG. 167. — Section showing Slotted End Piece.
FIG. 168. — Broom-handle Roller showing Pivot in End.

show the platform. Use a square piece of $\frac{3}{4}$-inch board for the base, and pieces of 1 by 2 for rim strips. Screw swivel casters to the base at the corners.

**A Towel-roller** like that in Fig. 166 requires a back board $3\frac{3}{4}$ inches wide and 21 inches long, with its face edges bevelled and a pair of holes drilled for attachment screws; also, a pair of bracket blocks $\frac{3}{4}$ inch thick and $2\frac{1}{2}$ inches square, (Fig. 167), with one end rounded,

and a piece of broom-handle roller 18 inches long (Fig. 168). Drive a large nail into a hole drilled in the center of each end of the roller, and file off the head, for pivots. Cut a slot in each bracket from the upper

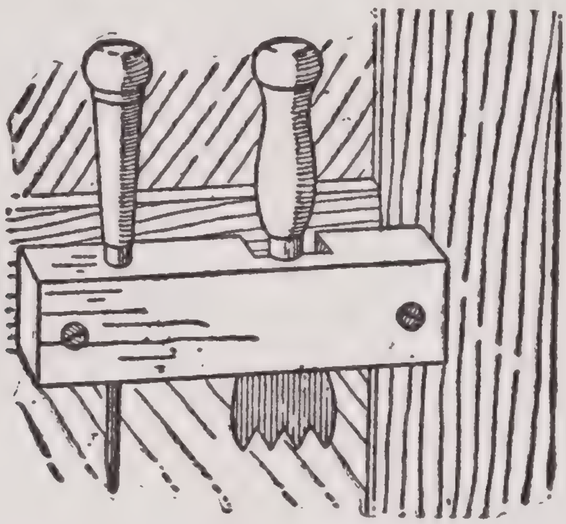
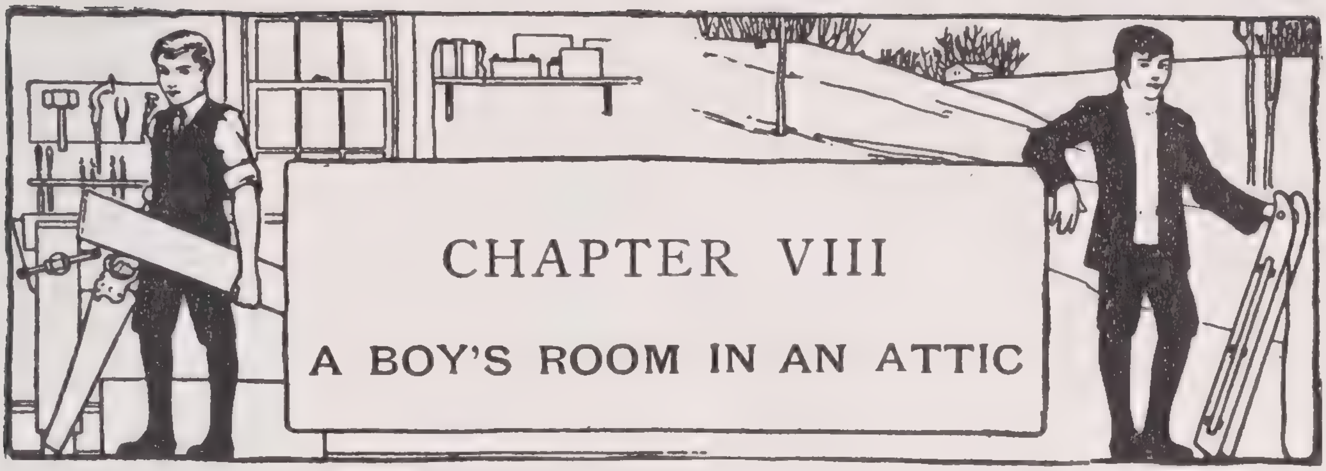


FIG. 169.—Ice-pick and Ice-chisel Rack.

edge down to the center, for the roller pivots, or screw a pair of window-shade brackets to the inside of the bracket blocks.

**A Utility Rack** like that shown in Fig. 169 is handy for ice-pick, ice-chisel, screw-driver and other kitchen tools.



# CHAPTER VIII

## A BOY'S ROOM IN AN ATTIC

The attic of the average house presents the best possible conditions for fitting up a boy's room, for generally it is a large unfinished space where a boy will have an excellent opportunity to partition off as large a room as he may require, and furnish it to suit his own taste with home-made furniture and all of his knickknack keepsakes. Usually an attic is the storage place for old trunks, antiquated furniture, and household truck, and this could very easily be packed together in such a way that a large enough space for a room would remain at one end. Figures 170 and 171 show how a room can be made in the attic of a house having a gable roof, but as one attic differs from another just as the house differs from another in plan and design, the suggestions will have to be modified to suit the conditions of your attic. Take a run up to the top of your house, boys, and look things over; then you can tell better just what you can do.

**A Dividing Partition** to separate the room from the rest of the attic should be built, first, and Fig. 172 shows the proper method of erecting the *studs*. If the attic walls

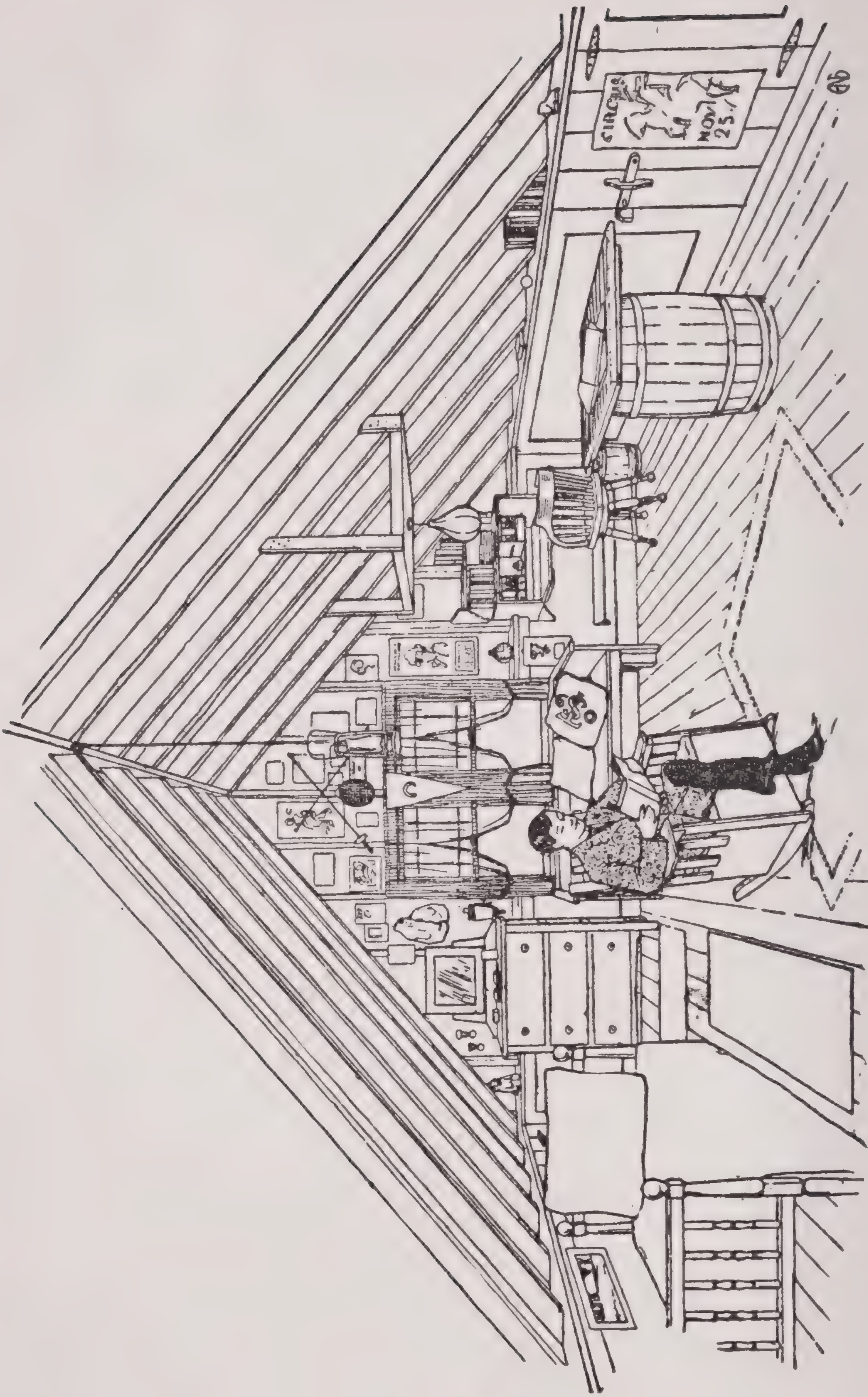



FIG. 170. — A Boy's Room in an Attic.

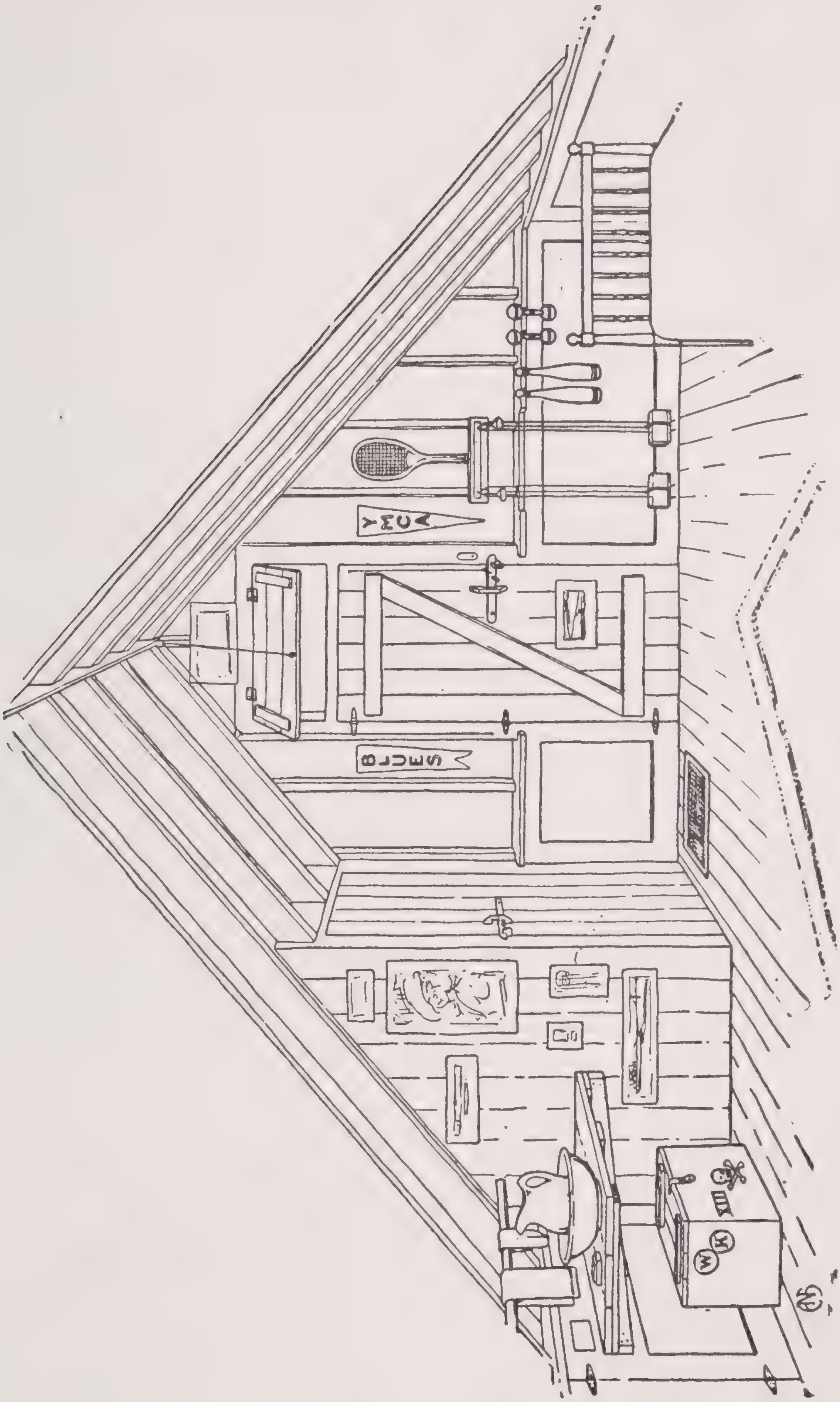



FIG. 171.—Opposite End of the Attic Room.

are unfinished and of frame construction, as shown in Fig. 170, it will look best to space the partition studs directly opposite the wall studs and nail the boarding on the outside face (Fig. 171); but they may be spaced 3 feet apart, to save lumber, and yet be close enough to support the boards.

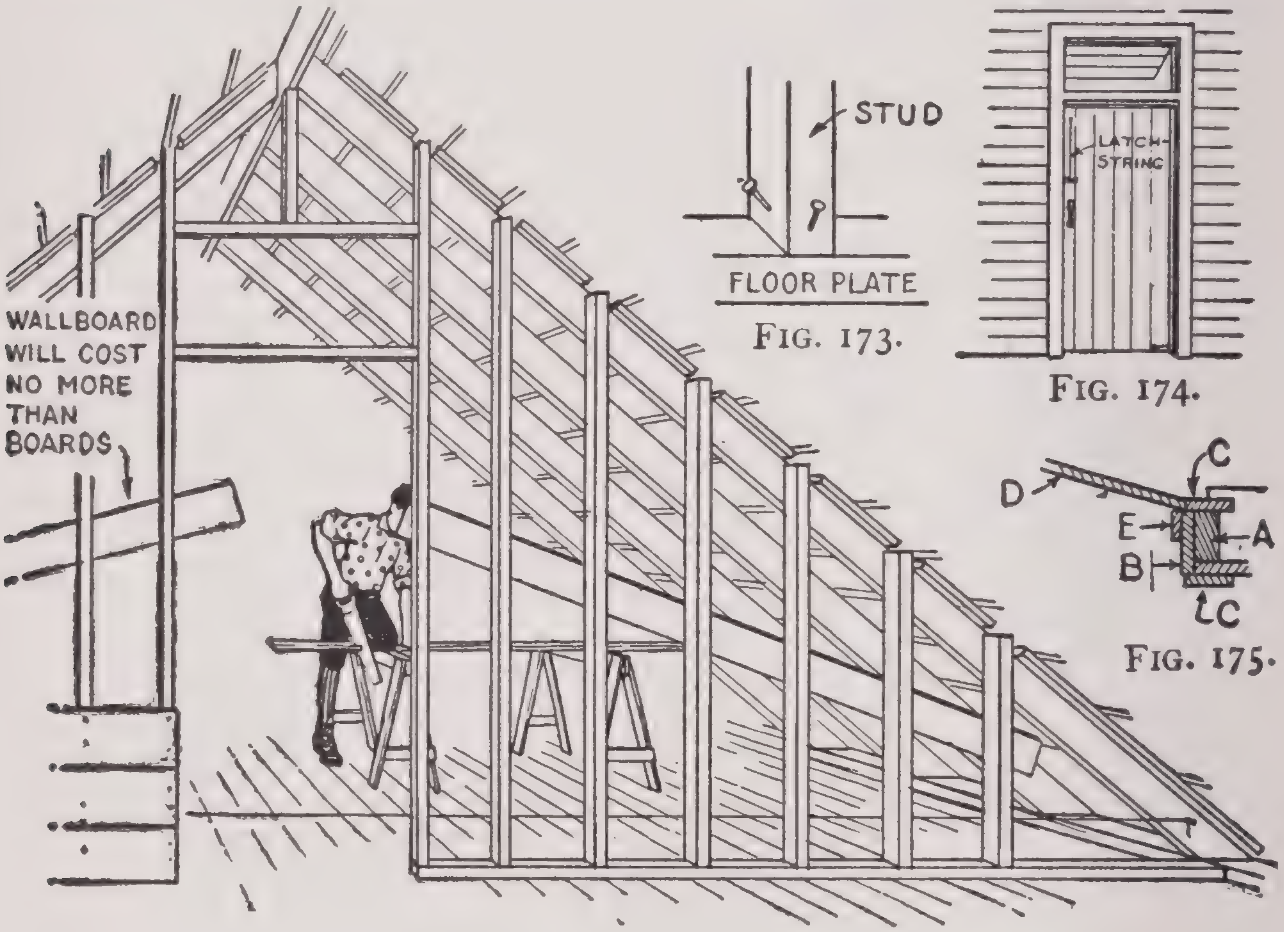



FIG. 173.

FIG. 174.

FIG. 175.

FIG. 172.

FIG. 172.—Studding for Dividing Partition.
FIG. 173.—Toe-nail the End of the Studs in this Way.
FIG. 174.—View of Outside of Entrance Door.
FIG. 175.—Plan showing Construction of Door Opening.

If you run the partition in the same direction as the roof rafters, locate it so the upper end of the studs may be spiked to the rafters (Fig. 172); if the other way, nail

a strip across the bottoms of the rafters to spike your studs to. The illustrations show the partition running in the direction of the rafters, so I shall tell you how to erect it in this way. To get the studs in a line, run

**A Plumb-line** from a nail driven into the face of one of the two rafters, 1 inch or so above the floor, to a nail driven into the face of the opposite rafter, as in Fig. 172. Spike a 2-by-4 plate to the floor with one edge even with the plumb-line. Stand the studs upon the plate and toe-nail them in place. If you haven't a spirit-level, plumb the studs with

**A Plumb-board.** This consists of a 4-inch board 5 or 6 feet long whose edges have been planed up straight and true, with a "V" notch cut in the center of one end and a cord with a weight attached tied to a nail driven into the center of the opposite end. By placing this board against the side of a stud, you can tell whether or not it is plumb by the position of the cord, which will hang exactly in the center of the notch when the stud is plumb. (This home-made plumb-board is illustrated on page 13 of "The Boy Craftsman.")

If you locate the door in the center of the partition, first set the two *jamb studs* 3 feet apart (Fig. 172) and *toe-nail* them to the plate and to the rafters (Fig. 173), then spike a cross-piece between these studs, 6 feet 9 inches above the floor, to form the *head* of the door, and fasten another horizontal piece about 20 inches above it for the head of the *transom*. Next, spike the end studs

in position, and nail on the temporary *diagonal braces* shown in the illustration to keep the studding plumb until the boarding has been nailed on. Space the intermediate studs at the proper distances apart, and, as soon as each piece is made plumb, tack the brace to it to hold it in position until you spike the ends in place.

It is not necessary to have new lumber for this partition. Boards and studs can usually be bought very cheaply wherever a frame building is being wrecked, and this second-hand stuff and box boards will do very well, for any roughness can be concealed. Studs may be spliced with *fish-plates* when too short (see *Fished-splice*, on page 58).

**If the Roof runs down to the Floor** along the sides of the room, a partition should be built along each side at a point where the roof is 3 feet above the floor, so the space behind these partitions may be utilized for

**Lockers**, an addition to a boy's room which cannot very well be dispensed with. These partitions are made as shown in Figs. 176 and 177. Short studs are fitted between the floor plate and rafters at every other rafter, a 1-by-2-inch strip is nailed across the studding near the top, the studs being notched so the strips will set flush with their face, as shown in Fig. 177, and then burlap, denim, or dark-colored muslin is tacked to these strips, and to the floor plates. The strips and covering should be carried around the other two walls of the room, also, to form a similar

**Wainscoting.** When the cloth has been tacked on, nail a 6-inch board around the bottom and another board of the same width around the top, and cut a board to fit between the rafters to form a shelf or cap over the wainscoting (Fig. 177).

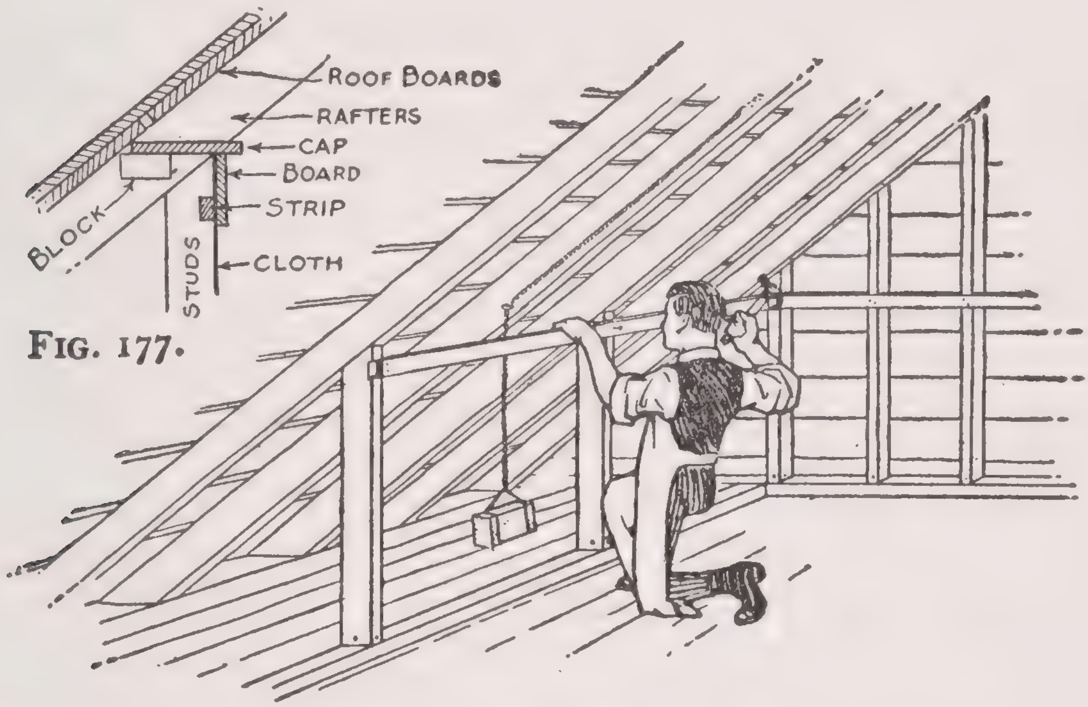



FIG. 177.

FIG. 176.

FIG. 176. — How the Wainscoting is put up.
FIG. 177. — Cross-section of Completed Wainscoting.

**A Large Clothes Closet** should be built in one corner of the room as shown in Figs. 171 and 178, and the inside should be fitted up with shelves, hooks, and coat and trousers hangers. A piece of broom-handle or curtain-pole may be fastened across the rafters upon which to hook coat hangers, hooks may be made out of spools (Fig. 179), and the

**Trousers Hangers** (Fig. 180) consist of two pieces of wood about 8 inches long, with one face of each beveled (*A* and *B*, Fig. 180), and a wooden button (*C*, Fig. 180).

Screw block *B* to the under side of a shelf, place block *A* parallel to it so the bevels will be about $\frac{1}{8}$ inch apart, and screw one end to the shelf; then screw button *C* in the proper position so when the ends of a pair of trousers are placed between the beveled sides of *A* and *B*, it can be turned against strip *A* as a lock to hold the two strips together.

FIG. 180.

FIG. 179.

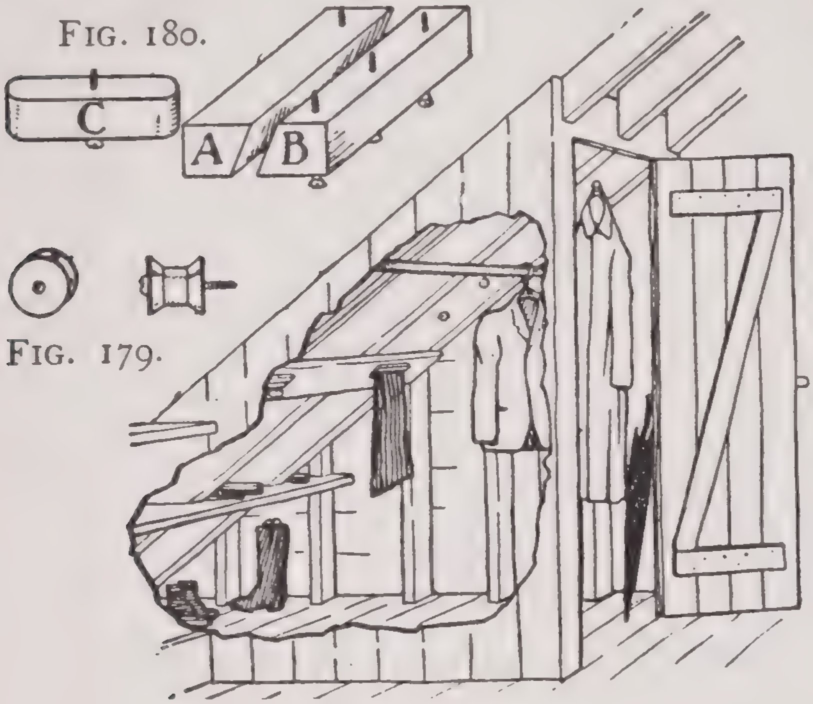



FIG. 178.

FIG. 178. — Clothes Closet, with Wall broken to show Inside.
FIG. 179. — Spool Hooks.
FIG. 180. — Details of Trousers Hangers.

**The Doors** should be made of boards battened together as shown in Figs. 171 and 178. To make a nicely finished entrance to the room, conceal the studding around the doorway with *jamb* and *head* boards, and nail a board *trim* around the opening as shown in Figs. 171 and 174. In the plan of the *door jamb* (Fig. 175), the stud on one side of the opening is shown at *A*, the finished *jamb* board at *B*, and the inside and outside *casings* or *trim* at *C*; the door is shown hinged in place at *D*, and the *stop* strip shown at *E* is nailed around the inside of the opening for the door to strike against. Hinge the entrance door and the locker doors on to the casings with strap-hinges (Fig. 171).

**The Entrance-door Transom** is made of boards battened together (Fig. 171) and is hinged at the top to the trim. It is operated by means of a cord which is run from a screw-eye in the bottom of the transom up over a small pulley in the ceiling, and from that down to a nail in the wall.

Figure 181 shows the details for

**An Old-fashioned Cabin Latch** which will do very well for the doors. By looking at Fig. 171, you will see that the *latch A* (Fig. 181) is screwed at one end to the door, the *guard B* is screwed in place over *A*, and the *catch C* is set into the jamb board. The entrance door should have a *latch-string* with which to open it from the outside (Figs. 174 and 181) and also a wooden *button* (*D*, Fig. 181) with which to lock it on the inside. Make a handle for the outside of the door similar to guard *B* (Figs. 174 and 181).

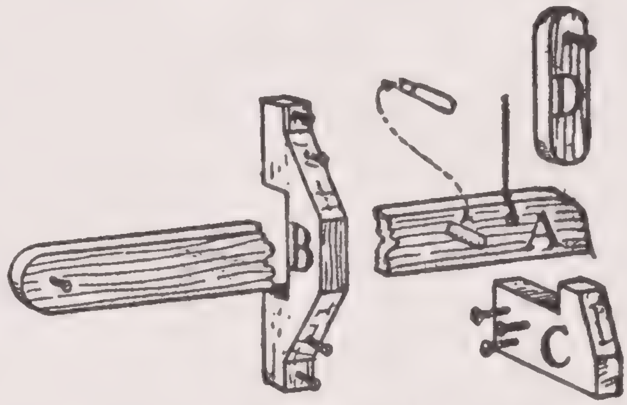


Fig. 181. — Details of Door Latch, Guard, Catch, and Button.

Few attics have provision for heating. Generally, the house heater isn't large enough to carry the load. But

**An Oil Heater or Stove** will make your room comfortable. If a chimney is available, run the vent pipe or smoke pipe into it. If not, get a tinner to make a stack of heavy galvanized iron, with hooded top, of a length that will extend through the roof to a point 6 inches or more above the roof peak.

If there isn't any running water in the attic, make

**A Wash-stand** in a corner, as shown in Fig. 171, to hold a wash-bowl and pitcher. Fasten

**A Broom-handle Towel-rack** above the wash-stand.

Get a common barn lantern for

**Lighting your Room.** Use it as an oil lamp, or wire it for electricity. Construct

**A Home-made Hanging Lamp** out of it as shown in Fig. 170. Besides the lantern, you will need a *harness snap*, a *screw-pulley*, a $\frac{5}{8}$-inch *screw-eye*, some *clothes-line* and

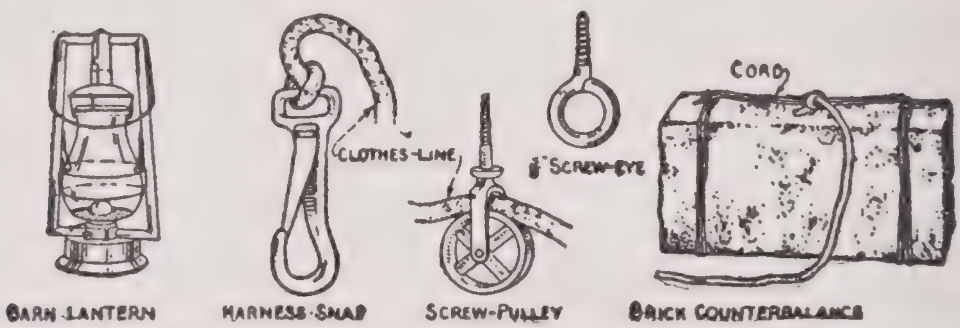



FIG. 182.—These things are required for the Adjustable Lamp Fixture.

*cord* and a *brick* (Fig. 182), and if you wire it for electricity, you will need a *socket*, *plug*, and *drop-cord.* Screw the pulley into the ceiling in about the center of the room, then run the clothes-line over the pulley and down the face of a rafter; screw the screw-eye into the rafter just above the wainscot cap (Figs. 176 and 177), slip the clothes-line through this eye and then run it through a hole bored through the wainscot cap, just below, and tie the brick to the end with cord for a counterbalance (Fig. 177); fasten the harness snap to the other end of the clothes-line and adjust it so that the lantern, whose handle is snapped into it, will pull

down to within easy reach of the floor. The weight of the brick must be just enough to counterbalance the lantern; if too heavy, break off a piece. Figure 170 shows the lamp pushed up out of the way.

Every one of you will have to suit your own taste in

**Furnishing the Room**, so the illustrations will serve merely as suggestions for the arrangement of pictures, pennants, fencing foils, tennis rackets, relics, and other things.

**Home-made Picture-frames** can be made out of laths very easily; *butt* the ends of the laths together instead of *mitering* them and stain the wood *in the rough* instead of planning it off smooth.

**The Furniture** may be very simple, like the box furniture shown in the following chapter, or some of the designs shown in Chapter VI may be carried out if you wish to spend more time and labor upon it.

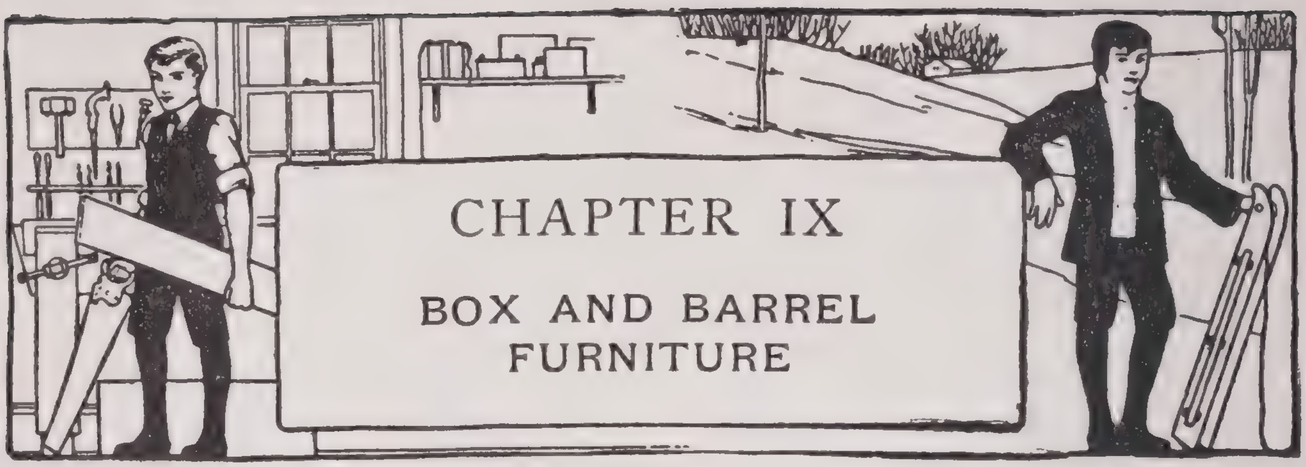
You will probably wish to make

**A Pirate Chest** such as is shown in Fig. 171 and

**A Window Seat** as shown in Fig. 170. Ask your mother to make a few sofa pillows for the seat.

Your attic room will be warmer in winter and cooler in summer if you will line the walls and ceiling with

**Insulation Material.** There are many kinds of material on the market, including the popular fiber-boards known as wallboard. The cost is less than that of lath and plaster. Suggestions for finishing an attic room with wallboard are given in Chapter III of "Big Book of Boys' Hobbies."



# CHAPTER IX

## BOX AND BARREL FURNITURE

Grocery boxes, packing-cases, crates, barrels, kegs, and much of the "truck" to be found in the attic, basement, and wood shed suggest innumerable possibilities for making things, and the fact that these materials can be utilized for many purposes with little or no expense makes them especially well suited to boys' work.

Furniture made from the above materials is naturally somewhat rough, compared with what can be produced with better wood, and some of it will appear clumsy, but no boy will object to this "home-made" appearance on furniture for his own room, if it will serve his purpose — in fact, he will generally prefer something like this in order that his room may be "different" from the other rooms of the house.

The following pages show a number of pieces of furniture which are easy to make, and other ideas will probably suggest themselves while you are working upon these.

**The Writing-desk** shown in Fig. 183 is fitted around the wall studding, which would be exposed in your room

if it were in the unfinished attic of a frame house; but it also may be fastened upon a plastered wall by supporting it upon brackets nailed to the wall, or by hanging it with chains from hooks screwed into the wall.

Procure a box about 30 inches long, 14 inches wide, and 16 inches deep for the body of the desk. The top

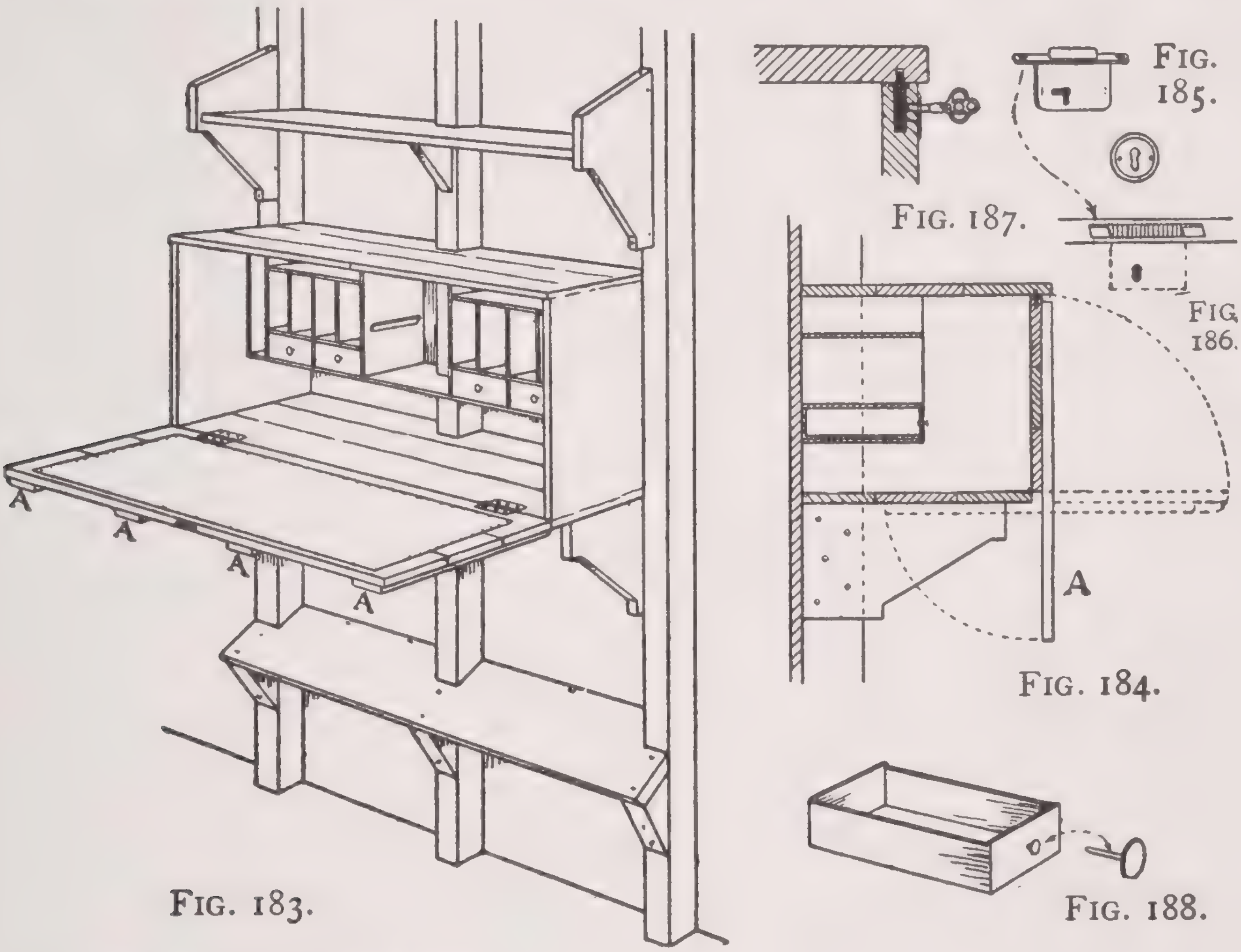



FIG. 183. — The Writing-desk.
FIG. 184. — Section through Writing-desk.
FIG. 185. — A Desk or Cupboard Mortise-lock and Escutcheon for Key-hole.
FIGS. 186–187. — How to set the Lock into the Drop-leaf of the Desk.
FIG. 188. — Cigar Box for Desk Drawers.

of this will form the front of the desk, and then the bottom will be the back, but in case the desk is fitted around the studs, the bottom boards should be removed,

as a back will be unnecessary. Figure 184 shows a good shape for bracket supports for the desk; after nailing these in place at the proper height, fasten the box to their tops. Make the *drop-leaf* for the front of the desk out of 1-inch boards and batten them together with four strips (*A*, Fig. 183). Cut the two end battens a little shorter than the width of the leaf, but make the two center ones long enough to project about 10 inches, as in Fig. 184, so they will strike the bottom of the box and prevent the leaf from dropping further when opened to the position shown by the dotted lines. Hinge the leaf in place as shown in Fig. 183. If you want a lock for the desk, go to a hardware store and buy a desk or cupboard *mortise-lock* (Fig. 185); this will cost 15 cents. Cut a mortise in the edge of the leaf of the proper size to receive the lock (Fig. 186), locate and cut the *keyhole*, and then screw the lock in place and fasten the *escutcheon* (Fig. 185) over the keyhole. A slot must be cut in the lower face of the desk top for a *pocket* for the *lock bolt* to turn into, and in order to make it possible to cut this pocket, the front board of the top must be removed and a board about 1 inch wider nailed on in its place; this will make a projection over the drop-leaf as shown in Fig. 187.

Very thin wood should be used with which to partition off the *pigeon-holes*, and pieces of cigar boxes will do nicely. Make the drawer openings of the right size so cigar boxes may be used for drawers (Figs. 183, 184, and

188), and drive brass rug tacks into the ends of the boxes for knobs.

To give the drop-leaf a better writing surface, pad it with a few sheets of newspaper and then cover the paper with a piece of white oil-cloth. Figure 183 shows how a foot-rest may be fastened to the wall, below the desk.

**A Shelf for Books** may be bracketed to the wall 10 or 12 inches above the desk as shown in Fig. 183.

It is generally an easy matter to find a broken chair, and you ought to be able to get a discarded piano-stool in your storeroom, from some neighbor, or at a second-hand store, as they are being replaced by the more modern piano bench, and having procured these two articles, you can make

**An Office Chair** such as is shown in Fig. 189. Remove the chair legs, then set the seat and back upon the stool (Fig. 190) and screw it to the top; countersink the screw-heads, fill in over the heads with putty, refinish

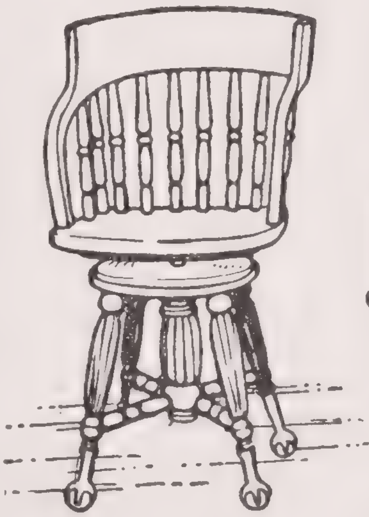


FIG. 189. — The Office Chair.

FIG. 190. — How the Seat and Back of a Chair are fastened upon a Piano-stool to form the Office Chair.

the chair to match the stool, and the office chair will be completed.

Procure a fish keg for

**A Waste-basket**, wash it out thoroughly, and paint it inside and outside. One of these kegs which has been used by the author for this purpose for a number of years is shown in the photograph opposite page 86.

**The Arm Rocker** shown in Fig. 191 is easy to construct. The seat is made out of a box with the cover boards nailed on, and the back and arm strips are cut out of pieces of boxes or other boards. If you can find a pair of rockers from a broken chair, use them and you will be that much ahead; if not, it is a simple matter to make a pair by laying a chair on its side upon a board, marking out around the rocker, then moving the chair over far enough to mark out the second rocker, and sawing out the pieces and smoothing them up.

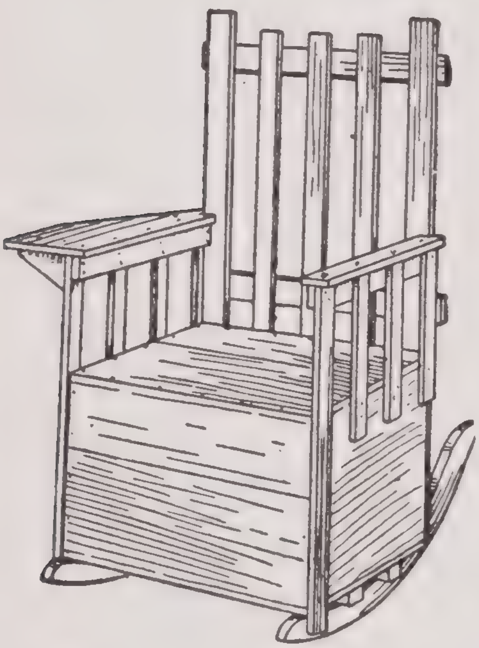


FIG. 191. — The Arm Rocker.

Figure 192 shows how the braces *A* should be nailed to the bottom of the box, and Fig. 193 how their ends should be cut to fit over the rockers. By looking at any rocking-chair you will see that the rear ends of the rockers are set several inches closer together than the front ends; provide for this in preparing strips *A*, and be care-

ful to set both rockers the same distance in, so the chair will rock evenly. Screw the rockers to strips *A*.

The arm rocker back should be constructed in one piece as shown in Fig. 194, and nailed to the box as in Fig. 192. Strips *B* are $2\frac{1}{2}$ inches wide by 2 feet 9 inches

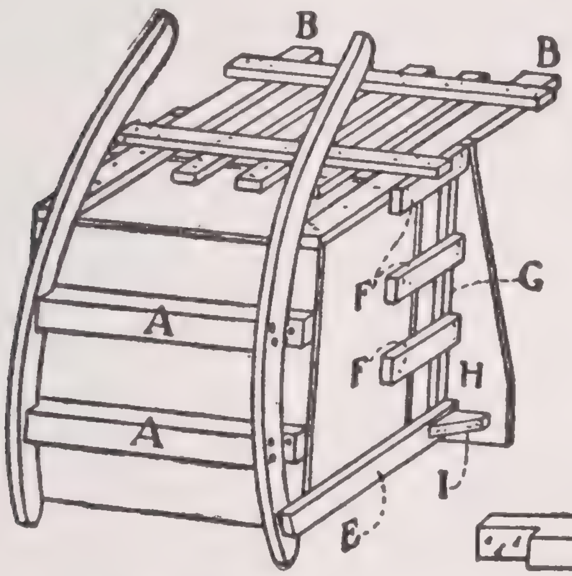



FIG. 192.


FIG. 195.

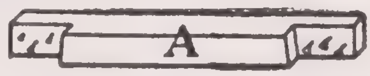



FIG. 193.

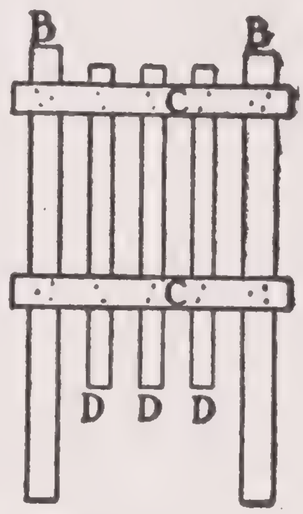
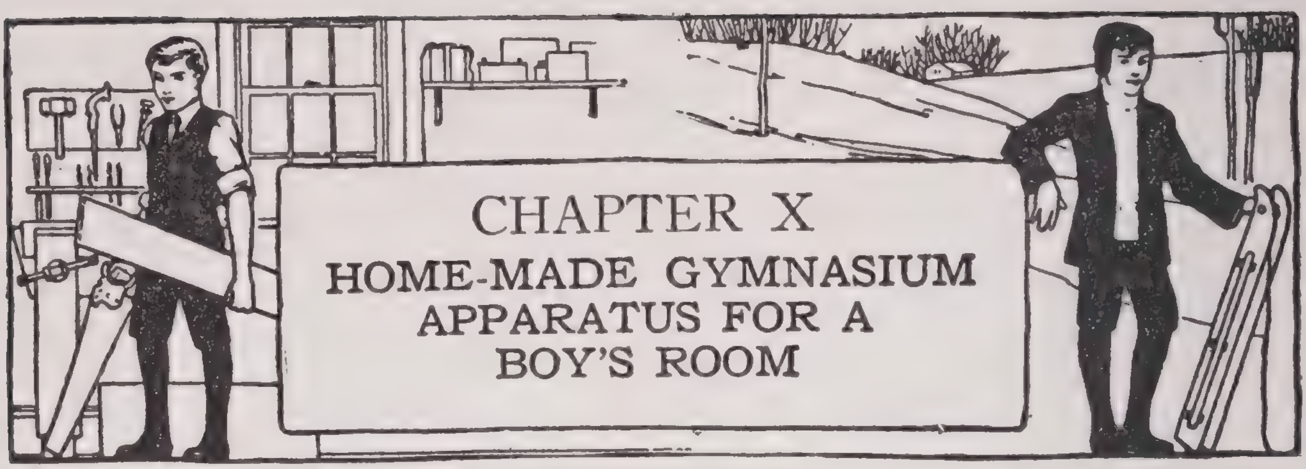



FIG. 194.

FIG. 192. — Chair overturned to show how the Rockers are Attached.
FIG. 193. — Brace for the Rockers.
FIG. 194. — How the Back is Constructed.
FIG. 195. — Pattern for the Wide Arm.

long, strips *C* $2\frac{1}{2}$ inches wide by 21 inches long, and strips *D* $1\frac{1}{2}$ inches wide by 2 feet long. After the back has been made and fastened to the box, cut the two side strips *E* (Fig. 192) $1\frac{1}{2}$ inches wide by 20 inches long, strips *F* to the same width by 10 inches long, and strips *G* to the same width by 16 inches long. Cut right arm *H* 18 inches long by 3 inches wide at the narrow end and 8 inches at the wide end, and cut the left arm of the same length by 3 inches wide. Brace the right arm with the small triangular block *I* (Fig. 192).



# CHAPTER X

## HOME-MADE GYMNASIUM APPARATUS FOR A BOY'S ROOM

It is not necessary to go to the basement or attic to fit up a home gymnasium, boys, unless you wish to make large pieces of apparatus, for you can easily equip your own room with a *rowing-machine*, *chest-weight*, *chinning-bar*, *hitch-and-kick*, *dumb-bells* and *Indian clubs*.

You will get a lot of fun and exercise out of

**A Rowing-machine** like that shown in Fig. 196. So will other members of the family. You can slide the machine under a bed out of the way when it is not in use. Metal glides on the bottom of the frame prevent its marring the floor.

As you will see by the detail drawings, the seat rolls forward and backward. It is pulled forward by the rower, and it is drawn backward by springs. In these movements, muscles of the arms, shoulders, back, trunk, thighs and legs are given a thorough workout.

The rowing-machine requires three 5-foot pieces of 2-by-4, two for side-rails and one for the end-plate, seat-blocks and foot-rest blocks, a 10-inch board 5 feet long for the seat and foot-rest, a section of a rug pole

or curtain pole 18 inches long for a handle-bar, a pair of roller-skates for rollers, four screen-door springs, a window-sash pulley, 5 feet of sash-cord, a ring-bolt, metal glides, screw-hooks, bolts, lag-screws and nails.

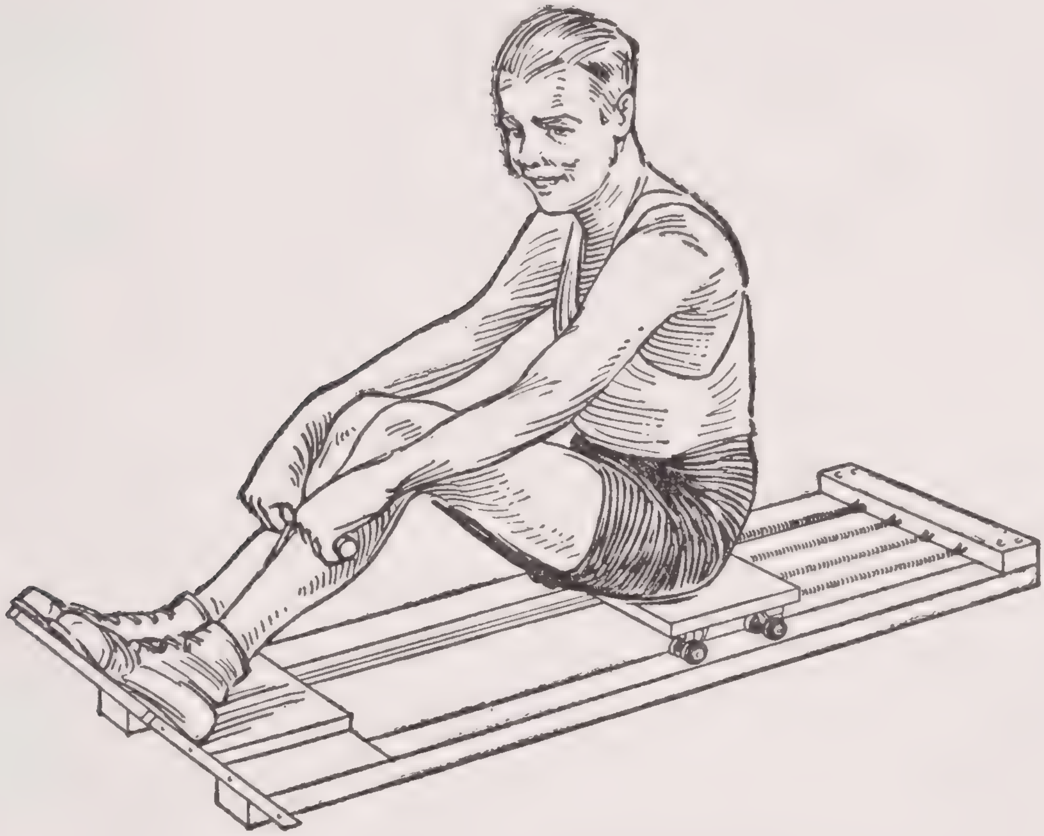


FIG. 196. — The Home-made Rowing-machine in Action.

The plan (Fig. 197) and the cross-section (Fig. 198) show the completed assembly. After cutting the side-rails and end-plate, bolt the plate to the rear ends of the rails. Countersink the bolt nuts on the under side of the frame (Fig. 199). Next, cut the 2-by-4 foot-rest blocks of the given length (Fig. 200) with their ends slanted at an angle of 45 degrees. Fasten these to the front ends of the side-rails with lag-screws (Figs. 199

and 201). Then cut the two foot-rest boards of the length shown, and screw one to the upper edges of the blocks, the other to the front ends. Reënforce the foot-rest by nailing a cleat to each end of the pitched board, as shown in the detail. Cut a mortise in the

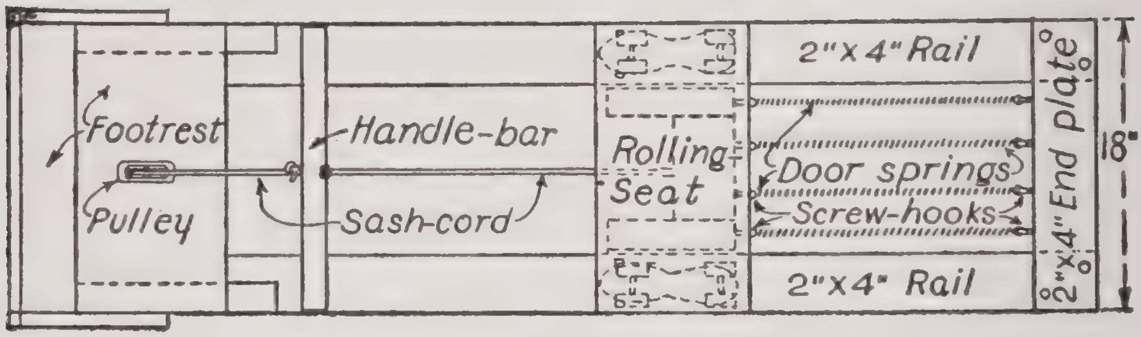



FIG. 197. — Plan of the Rowing-machine.

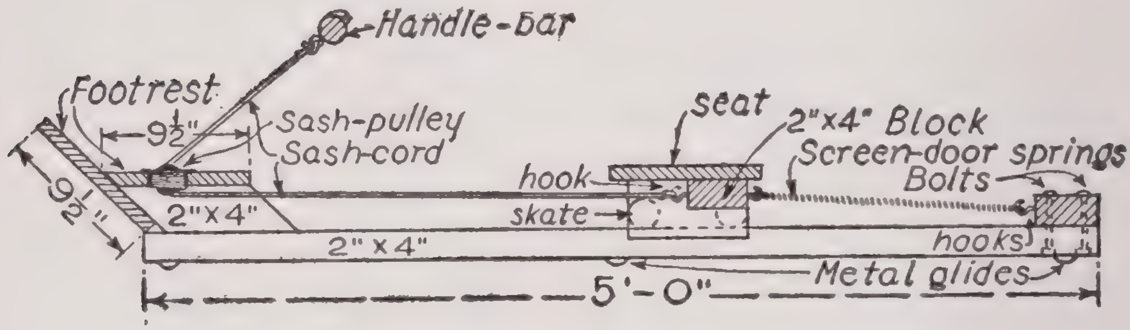



FIG. 198. — Cross-section of the Rowing-machine.

center of the foot-rest for a sash-pulley (Fig. 202) to fit in, and drive the pulley into the mortise.

Figures 203 and 204 are details of the rolling-seat. Cut the seat board and 2-by-4 blocks of the sizes indicated, and nail the board to the blocks. Two blocks are set on edge to slide along the inner face of the side rails, for guides. Bolt the roller-skates to the seat board outside of the guide-blocks. To complete the

seat, screw four screw-hooks into the back of the blocks, and one into the front of the center block.

To hook up the rolling-seat, slip four screen-door springs over the hooks in the back of the blocks, and

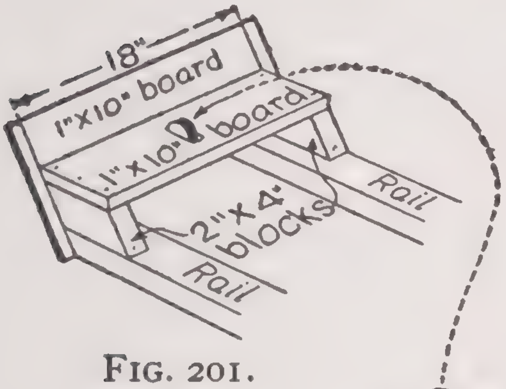



FIG. 201.

FIG. 202.

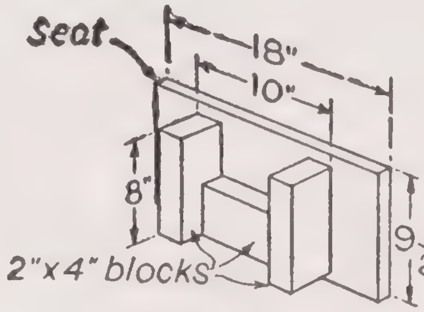



FIG. 203.

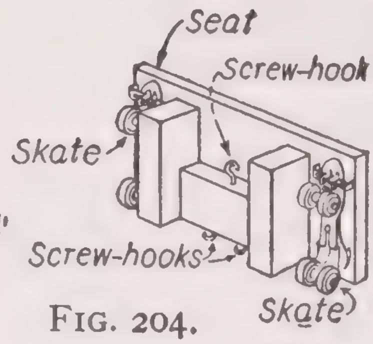



FIG. 204.

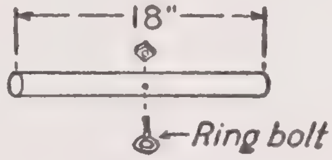



FIG. 205.

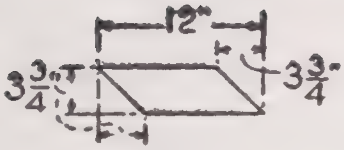



FIG. 200.

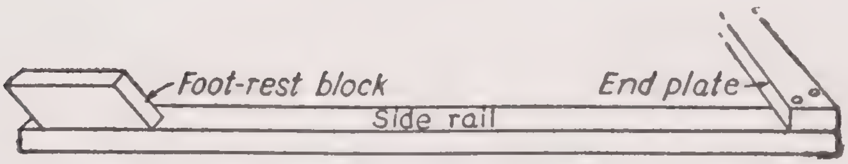



FIG. 199.

FIG. 199. — Side-rail, End-plate, and Foot-rest Block.
FIG. 200. — Pattern for Block.
FIG. 201. — Detail of Foot-rest.
FIG. 202. — Sash-pulley.
FIGS. 203 and 204. — Details of Rolling Seat.
FIG. 205. — Detail of Handle-Bar.

over hooks screwed into the end-plate in line with the seat-hooks (Fig. 197). Fasten the sash-cord to the front seat-hook, and run it over to and through the pulley. Make a handle-bar of a section of rug pole

18 inches long with a ring-bolt fastened to the center (Fig. 205), and join the sash-cord to the ring. To determine the length of the sash-cord, seat yourself upon the rolling-seat, bend forward and extend your arms. The handle-bar should be within your grasp when you are in that position.

With the rowing-machine assembled, take it down for finishing. Remove the seat, cord, and springs. Sandpaper all surfaces, and round all edges and corners with a plane. Then shellac, rub down again with fine sandpaper, and apply a coat or two of varnish, lacquer, or enamel. Drive metal glides into the under face of the side-rails, at the ends and center.

**A Chest-weight,** or "exercising machine," as some boys call it, is shown in Fig. 206, and Figs. 207, 208, and 209 give the details for making it. Select a portion of a wall in your room where it will be most convenient to use the weights, and if the wall is frame, — that is, made of wood and plaster,—locate two of the studs (Fig. 207). Tap upon the plaster with a hammer until you find a portion that sounds solid, make a mark there, then measure 16 inches to the left or right of it, and the chances are you will find the second stud at that point, as studding is generally placed 16 inches from center to center. If the wall is brick, locate two of the vertical strips to

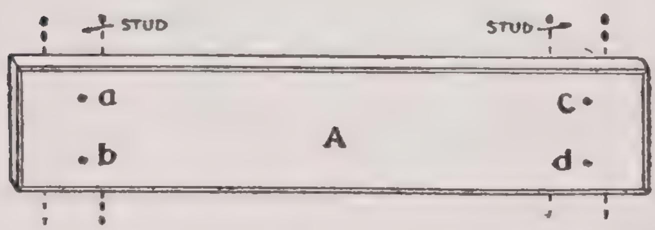



FIG. 207. — Screw the Cross-piece of Chest-weight to Wall Studs like this.

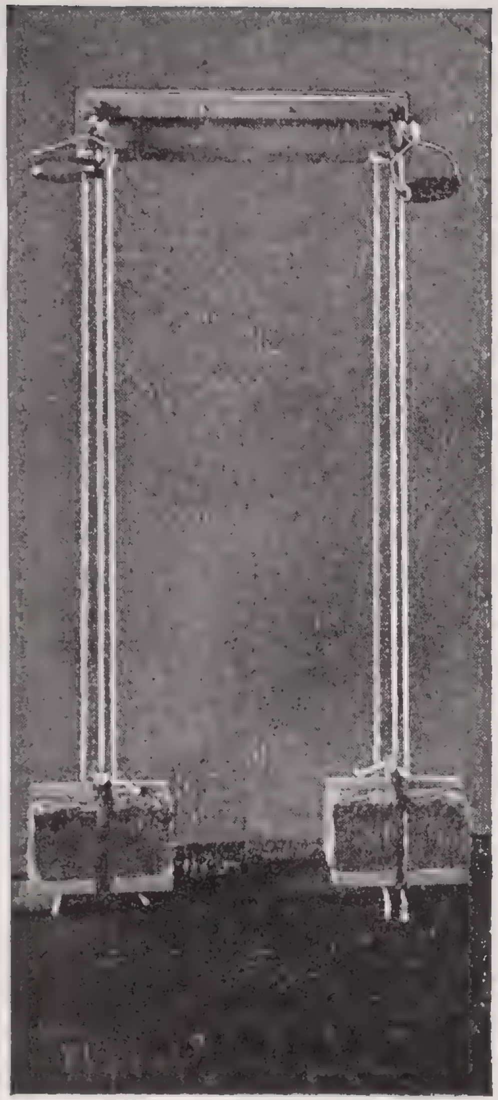


Fig. 206. Construct Your Chest-Weights First.

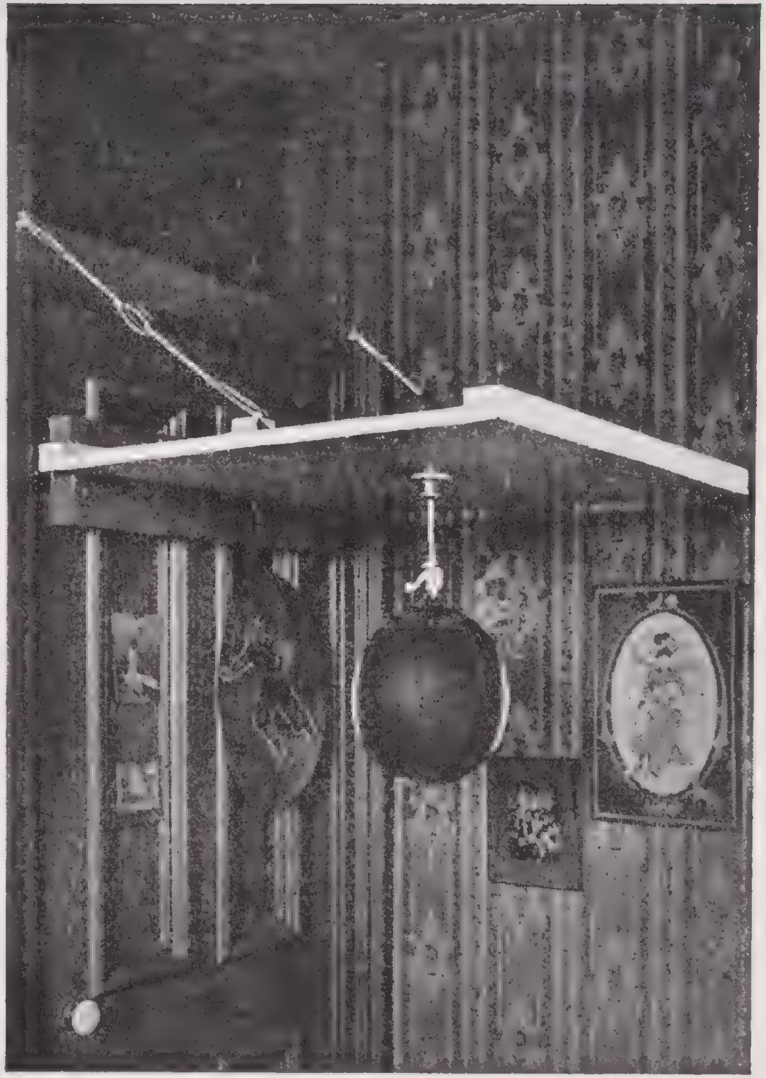


Fig. 210. Where to Hang the Striking-Bag.

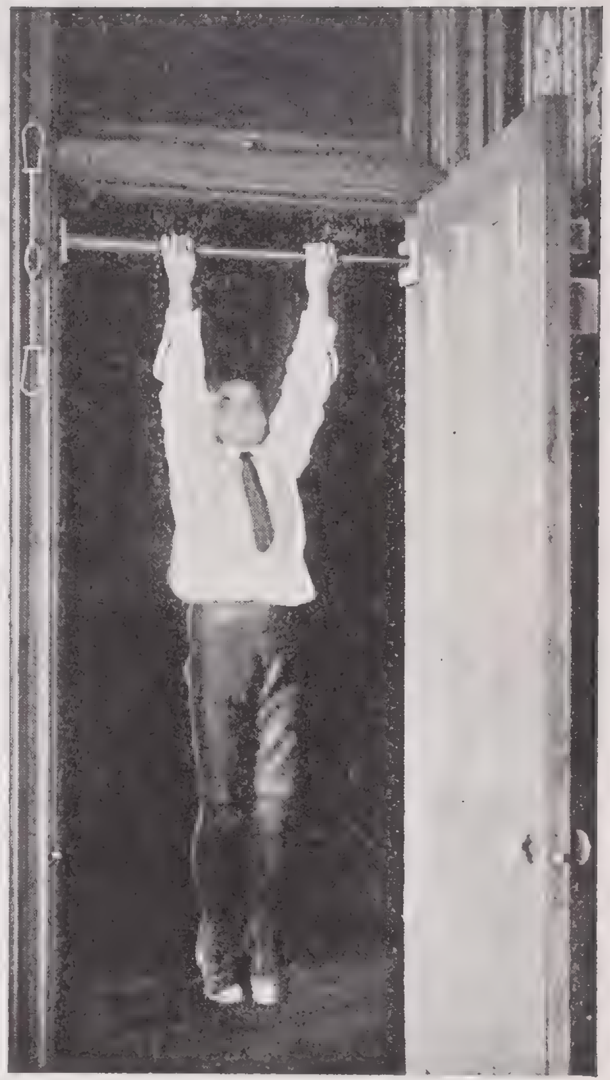
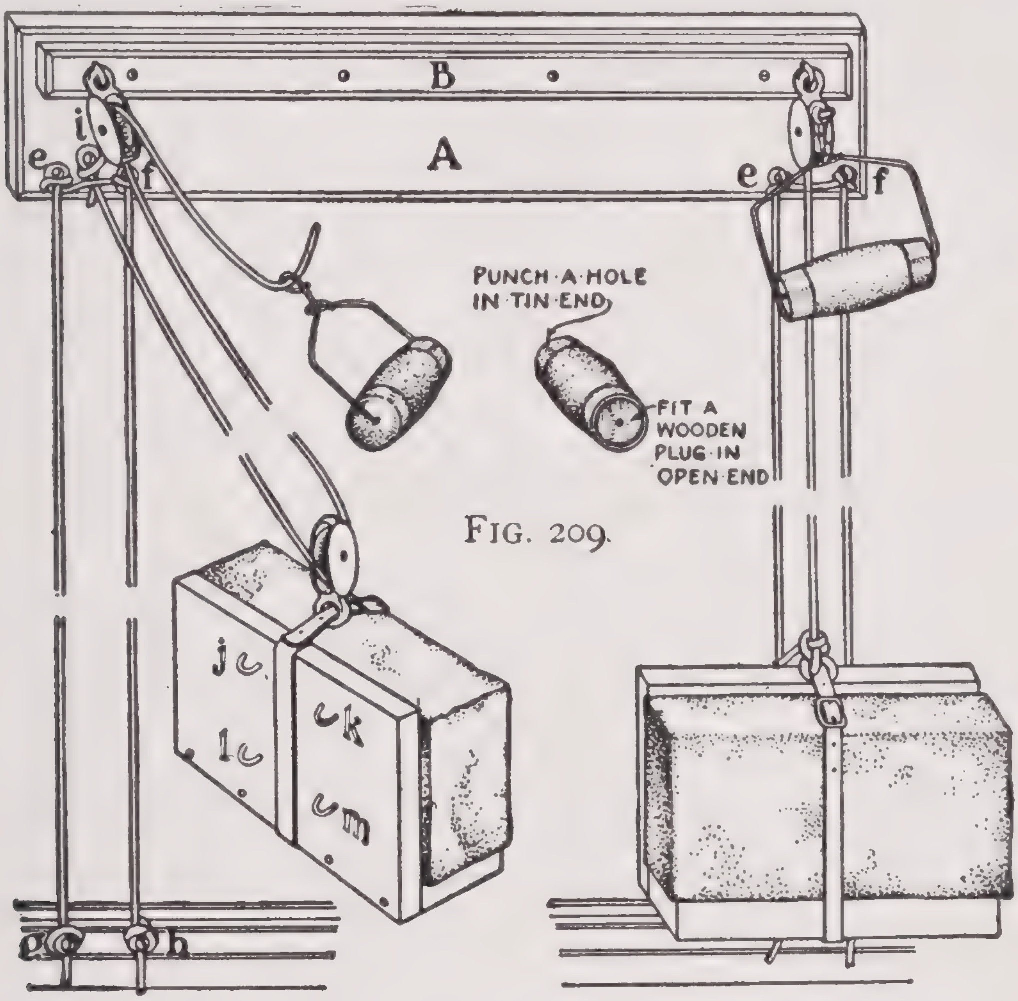


Fig. 215. The Doorway Chinning-Bar is Easily Put Up.

which the laths are nailed. For cross-piece *A* (Figs. 207 and 208) cut a 1-inch piece of oak, pine, or whitewood, 4 inches wide and 20 inches long, plane it up and bevel its




Two-pulley Scheme. FIG. 208. One-pulley Scheme.

FIG. 208. — Two Schemes for Assembling the Weights, Rope, and Pulleys of Chest-weight.

FIG. 209. — Prepare a Pair of Bicycle Handle-bar Grips like this for Handles.

four face edges. Locate holes *a*, *b*, *c*, and *d*, 2 inches from the ends, and bore them $\frac{1}{4}$ inch deep with a $\frac{3}{8}$-inch bit. Spike the board to the wall about on a line with your shoulders, using 20-penny nails and driving them through holes *a*, *b*, *c*, and *d* into the studs. Drive the heads below the surface of the wood with a nail-set,

and fill holes *b* and *d* with chips of wood cut to fit over the spike heads (holes *a* and *c* will be concealed by strip *B* as is shown in Fig. 208). Cut cross-piece *B* 19 inches long by $1\frac{1}{4}$ inches wide, bevel its edges, and screw it to board *A* with round-head finishing-screws (Fig. 208).

Procure two bricks of uniform size for weights, make a wooden bracket for each as shown in Fig. 208, and strap them to these brackets with a couple of skate, trunk, or shawl straps. Drive staples into the backs of the brackets at *j*, *k*, *l*, and *m* (Fig. 208), placing *j* and *k* 1 inch to each side of the center and *l* and *m* directly under them.

Purchase two enameled-iron awning pulleys at a hardware store, also get about 25 feet of *sash-cord*, or closely woven clothes-line, for *lifting-lines* and *guide-ropes*. Fasten the pulleys to cross-piece *B* with staples, $1\frac{1}{2}$ inches from the ends. The guide-ropes are fastened to screws *e* and *f* in board *A* and to *g* and *h* in the baseboard. These screws should be placed 2 inches apart, and should center on the pulleys on strip *B*. In attaching the ropes, first fasten them to screws *e* and *f*, then slip their lower ends through staples *j* and *l*, and *k* and *m*, in the weight brackets, and tie them to screws *g* and *h*. You can make either a one-pulley scheme for lifting your weights as shown on the right of Fig. 208, or a two-pulley scheme as shown on the left of the illustration. The latter way has the advantage of a longer rope, but costs a little more on account of the extra rope and

pulleys. In the first method the rope is attached to the bracket strap, then run through the pulley and tied to the handle, while in the latter it is tied to screw *i* on board *A*, run through a pulley, slipped over the bracket strap, and then slipped through the upper pulley and tied to the handle.

The handles are made from bicycle *handle-bar grips*, which, if you haven't an old pair, may be purchased for 10 or 15 cents. Glue a wooden plug in the open end of the grip (Fig. 209), then bore a hole through the center of it and punch another hole through the center of the tin cap on the other end of the grip. Run an 18-inch piece of heavy wire through the holes and bend it into the shape shown in the illustrations, with a hook through which to tie the lifting rope. Leave the bricks in their natural color, or stain them with oil paint, and either stain or varnish the woodwork if it is of oak, or paint, stain, or shellac it if it is of pine or whitewood.

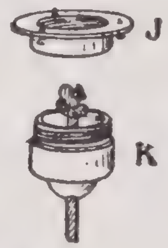
**A Striking-bag** with an elastic cord at each end can easily be fastened in a doorway by screwing a screw-eye in the head and another in the threshold, to which to tie the cords. The upper screw-eye may be left in place and the lower one removed when you detach the bag. But for a bag with a single cord it is necessary to have a platform for it to strike against. You can put up

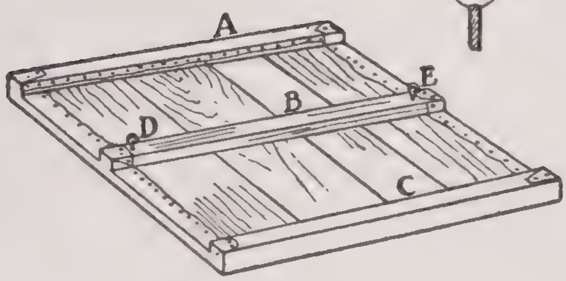
**A Striking-bag Platform** in your room by making it detachable, as shown in Fig. 210, so that it may be removed and put out of the way when not in use.

Make the platform 3 feet square, battening together the boards with strips *A*, *B*, and *C* (Fig. 211), and screw hooks *D* and *E* into strip *B*. Cover the under side of this platform with oilcloth to make the surface smooth, first tacking several thicknesses of paper over the boards if there happens to be any uneven places.

To the inside of your room door screw the piece of 2-by-4 *F* (Fig. 212), 2 inches above your head, then

FIG. 214.



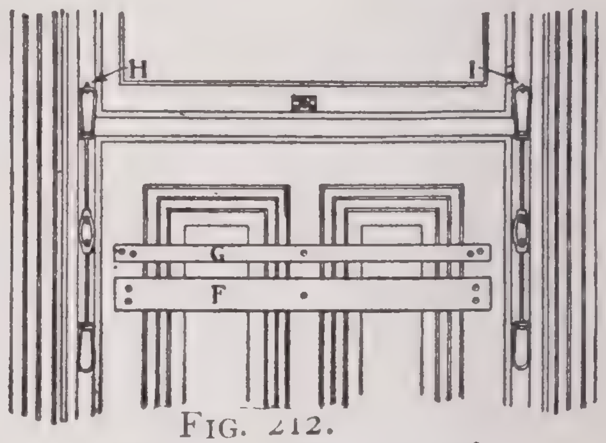




FIG. 212.

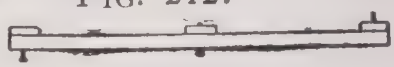


FIG. 211.

FIG. 213.

FIG. 211. — How to make the Striking-bag Platform.
FIG. 212. — Attachment of Strips to form Groove for Platform; also Turnbuckles.
FIG. 213. — Block out the Strips thus if the Door has Raised Panels.
FIG. 214. — Details of the Swivel which holds the Bag Cord.

leave a space wide enough for end *A* of the platform to fit in, and screw strip *G* to the door. If the door has raised panels (Fig. 210), block out strips *F* and *G* as shown in Fig. 213. Purchase two buck-saw *turnbuckles* at a hardware store, and fasten one end of each to the door *trim* with staples, at *H* and *I* (Fig. 212); put them just high enough so the lower ends will catch in hooks *D* and *E* (Fig. 211) when the platform is slipped between

*F* and *G*. The platform is made solid by turning the turnbuckles. The swivel shown in Fig. 214 costs about 50 cents. The plate *J* is fastened to the under side of the platform with screws, the bag cord is slipped through *K* and knotted, and *K* is screwed on to *J*.

**A Chinning-bar** is very easily put up in a doorway (Fig. 215). A piece of a curtain-pole will do for the bar, and the socket-blocks for it to set in should be made as shown in Fig. 216. Cut the blocks 4 inches square and make the holes a little larger than the ends of the curtain-pole. Figure 217 shows how to cut the holes by first boring a ring of little holes and then cutting out the center and trimming up with a chisel. Make the hole in block *B* like that in *A*, then saw a piece out of the top. Screw the blocks to the door jambs about 3 inches below the door *head*.

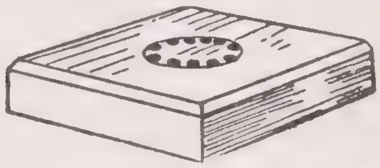


FIG. 217.

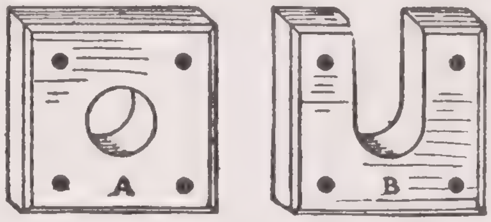


FIG. 216.

FIG. 216. — Socket-blocks for the Chinning-bar.
FIG. 217. — How to cut a Large Hole.

**The Hitch-and-Kick** (Fig. 218) is a piece of apparatus that will give you a chance to limber up your leg muscles by practicing the *high kick*. The plate (Fig. 219) may be an old *pot cover* or a *cake-tin*, with three holes punched at *A*, *B*, and *C*. Attach brass chains at these holes, join them at *D*, and at this point connect the end of a piece of chain 12 or 14 feet long. Fasten a small screw-pulley or a screw-eye in the ceiling (Fig. 218), slip the chain

FIG. 218. — The Hitch-and-Kick will give you a Good Chance to Limber up your Leg Muscles.

through it, and bring the end down through a screw-eye and then to a hook which has been screwed into the door or window *trim*. You may have a long stick, graduated into feet and inches, with which to measure the heights of your kicks; or you may tie a short piece of thread through one of the links of the chain, within a foot or so of the loose end, and then lay off some measurements upon the door or window *trim*, in lead-pencil, in such a way that you can easily determine the height of the plate by noting the position of the threaded link.

With the addition of a pair of *dumb-bells*, a pair of *Indian clubs*, and **a wand** made by splicing together two broom-handles, as shown at *A*, *B*, and *C* (Fig. 220), you will have a fairly well-equipped "gym," without sacrificing any floor space of your room for apparatus.

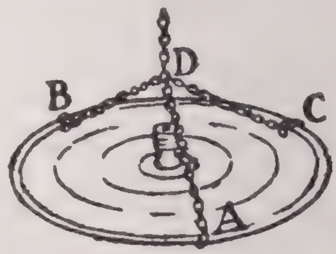



FIG. 219 — How to make the Hitch-and-Kick Plate out of an Old Pot Cover.

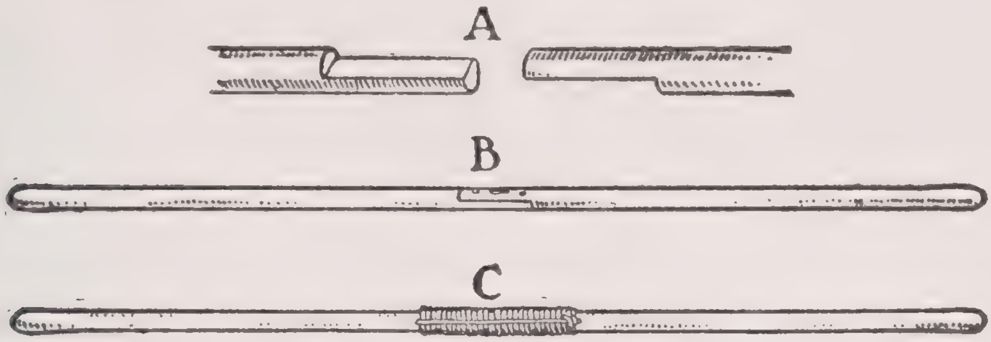



FIG. 220. — A Wand made of Two Broom-handles spliced together End to End.

**A Rack for your Dumb-bells, Indian Clubs, and Wand** may be made like the one illustrated by Fig. 221. Board *A* is the same size as board *A* of the *Chest-weight* (Fig. 207) and is spiked to the studs in the same way, while board *B* is 2 inches shorter and $2\frac{1}{2}$ inches wide. Make the places for the *bells*, *clubs*, and *wand* to set in as shown in Fig. 222, cutting them as described for the *Chinning-bar* socket *B* (Fig. 216). Screw strip *A* to strip *B*.

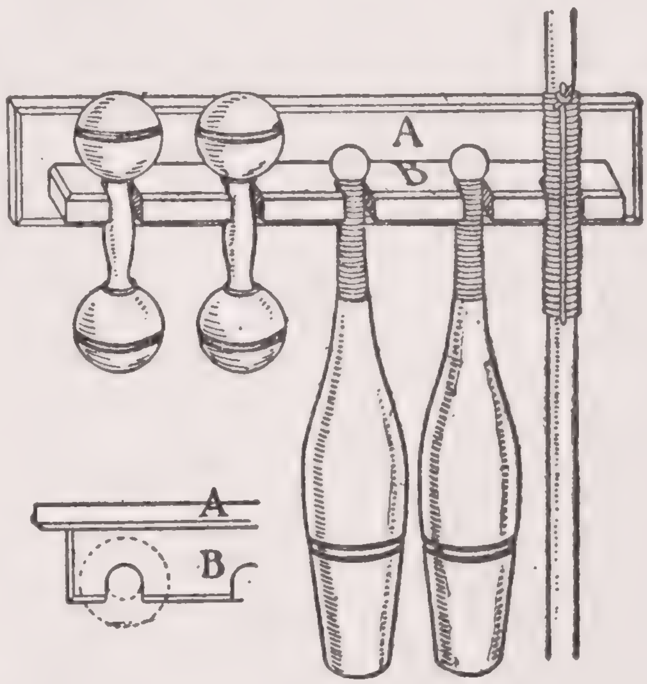
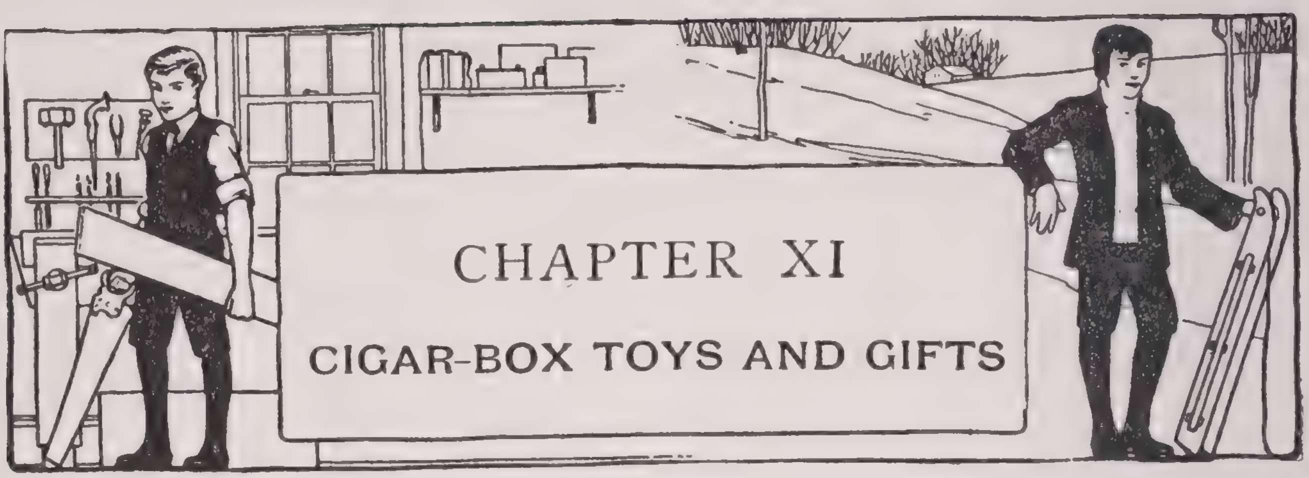



FIG. 222.
Plan showing how to cut the Sockets.

FIG. 221.
Rack for Dumb-bells, Indian Clubs, and Wand.

Other ideas for home-made gymnasium apparatus will be found in Chapter XLVIII of "Big Book of Boys' Hobbies." These include a *trapeze*, *flying-rings*, *a horizontal-bar*, *parallel-bars*, a *tumbling-mat*, and a *striking-bag platform.*



# CHAPTER XI

## CIGAR-BOX TOYS AND GIFTS

MAKE your Christmas gifts, boys; your own handicraft will be better appreciated by your brothers and sisters, the older folks, and the friends and relatives you wish to remember than anything you can buy, and as the materials may be such as will cost little or nothing, you can save the greater part of the money you usually spend in Christmas shopping. Besides, by showing your work to friends it should be easy to secure orders for duplicate articles.

Probably no material presents as many possibilities for making inexpensive and at the same time attractive articles as the white cedar wood from cigar boxes. You boys very likely know what handy receptacles these boxes are for stamps, coins, marbles, and the hundred and one other things which your pockets will not hold, but here are some ideas for making use of the boxes which you probably never thought of.

**The Material** will cost you nothing, — except the nails, glue, and finish, — as empty cigar boxes may be procured at any cigar store or drug store. Pick out a good assort-

ment of shapes and sizes, place the boxes in a tub or wash-boiler of hot water and allow them to soak until the paper labels and bindings loosen, then, when this paper has been removed, bind the covers flat against the bottoms with cord to prevent them from warping, and put them in the sun or near a stove to dry. When the boxes are thoroughly dry, pry them apart, sort out the best pieces and remove the manufacturers' trade-marks with sandpaper (grade No. 0).

Brads $\frac{3}{8}$ inch or $\frac{1}{2}$ inch long should be used for nailing, and the heads should be *set* below the surface of the wood and the holes filled with putty colored to match the wood.

**Finish** the work with two coats of boiled linseed-oil. The oil gives the wood a beautiful rich tone and brings out the markings of the grain.

A scroll-saw, bracket-saw, coping-saw, or a very sharp jack-knife should be used where

**Cutting** is necessary. Do not attempt to split the wood, as the grain is seldom straight, but lay it down upon a board and *score* it with a knife in the way in which you would score a piece of cardboard; then break it along the scored line, or continue cutting until the piece is cut in two. If you use a saw, cut a little away from the outlines of the work and then trim up with a knife and sandpaper.

The wagons, Jack-in-the-box, and doll furniture shown in this chapter were designed with the idea of saving as

much cutting as possible, and you will see by the illustrations that in many cases the boxes are not altered.

**The Express-wagon** shown in Fig. 223 is made out of a long flat box. Cut down the sides at the front and construct a seat on top of the sides as shown in Fig. 227. Cut the front wheels about $2\frac{1}{4}$ inches in diameter and the rear wheels about $2\frac{3}{4}$ inches in diameter. You can mark out the wheels with cups or glass tumblers. Small bottle corks glued to the wheel centers will make good hubs. Cut the wooden axles as shown in Fig. 227, making the front axle—for the smaller wheels—deeper than the rear one, then fasten them to the wagon and nail the wheels to their ends. Drive a tack into the front of the wagon-box and tie a cord to it, or if you have a small toy horse to hitch to the wagon, fasten a pair of shafts to the under side of the box as is shown upon the two-wheeled cart.

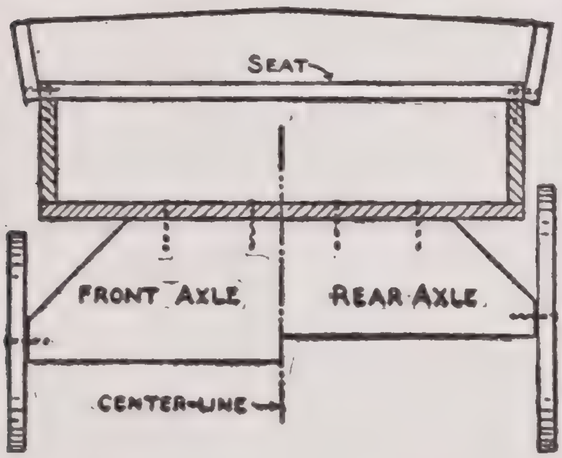


FIG. 227. — Cross-section of the Express-wagon.

**The Cart** in Fig. 224 is made out of a square flat box with its wheels fastened to the center of the under side. Make the wheels about $2\frac{3}{4}$ inches in diameter.

**The Light Auto Truck** (Figs. 225 and 226) requires two boxes about $8\frac{1}{2}$ inches long, 5 inches wide, and $2\frac{1}{2}$ inches deep. You will see by looking at the illustrations that one box is inverted upon the other. Before fasten-

ing them together, remove the two ends of the upper box and the rear end of the lower box (leaving the front end for the *dashboard*), and cut 2 inches off the sides at the front and an additional piece 1 inch by $1\frac{3}{4}$ inches from the sides of the upper box for windows. Fasten the boxes together by nailing strips to the ends of side pieces. Nail a narrow strip across the top of the rear end of the body and hinge a drop *end-gate* to the body-end with cloth strips. Support the end-gate with a cloth strap. Tack a curtain of black cloth to the top cross strip and sew two cloth straps to the curtain, so that it may be fastened up in a roll, as shown in the photograph. Make the wheels and axles like those of the express wagon, but cut the front and rear wheels, also the two axles, of equal size. Cut out a small steering-wheel and fasten it on a short wooden rod inside of the dashboard. Make a seat and seat back, nail the back to the seat, and then fasten the seat between the sides of the body just below the windows.

**A Jack-in-the-box** (Fig. 228) is a simpler toy to make than you might imagine. The box should measure about $5\frac{3}{4}$ inches by $5\frac{3}{4}$ inches by 5 inches. Hinge the cover to the top with two pieces of heavy cloth; glue one piece to the inside of the cover and box, and the other to the outside. Drive a small tack into the front edge of the cover, and below it fasten a small hook onto the box; the hook may be bent from a short piece of wire.

A spiral spring from an old bed-spring will do for Jack's

body, but if you cannot get one of these, it is a simple matter to make a spring. Take a piece of No. 12 gauge wire about 10 feet in length and wind it around a rolling-pin or anything that is cylindrical and about $2\frac{1}{2}$ inches in diameter. Fasten this spring with doubled-pointed tacks upon a piece of wood cut to fit the inside of the box (Fig. 229), then procure a small doll's head, baste a circular piece of cardboard to the top of the spring and to this sew the head. Make a cloth fool's cap to glue on Jack's head, covering his hair entirely, and also a loose jacket to fit over his spiral body; for these use any bright-colored cotton cloth that will fall into folds easily. Tack the base of the spring to the bottom of the box.

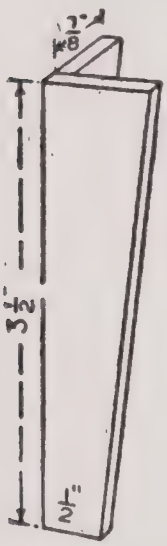


Fig. 236. Leg of Dining-table.

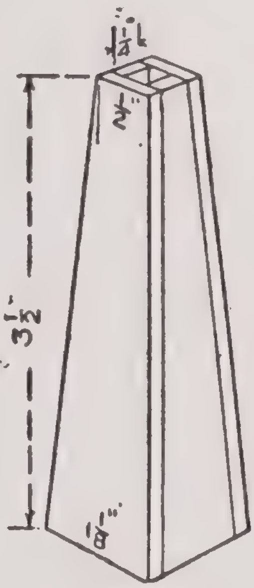


Fig. 235. Pedestal of Center-table.

Make the seat for

**The Round-seated Chair** shown in Fig. 230 2 inches in diameter, the back 5 inches high, 2 inches wide at the top, and $1\frac{1}{4}$ inches wide at the seat; cut the front leg $2\frac{1}{8}$ inches high by $1\frac{1}{4}$ inches wide.

**The Round Center-table** (Fig. 231) should have a base built up of four strips as shown in Fig. 235. Cut the circular top 5 inches in diameter. A saucer may be used with which to mark this out.

Select a long flat box for

**The Dining-table** shown in Fig. 232, and after making

four built-up legs as shown in Fig. 236 fasten them into the four corners of the box.

In making the little

**Square-seated Chair** (Fig. 233), cut the seat about 2 inches wide by $2\frac{1}{4}$ inches deep, the front legs $2\frac{1}{8}$ inches high by $\frac{3}{8}$ inch wide, and the back legs $4\frac{1}{2}$ inches high by $\frac{3}{8}$ inch wide. Brace the legs and back with cross-pieces, and you will have a very firm and artistic dining-room chair.

Select a box about 9 inches by 5 inches by $2\frac{1}{4}$ inches in size for making

**The Doll's Cradle** shown in Fig. 234. Cut the two rockers by the pattern in Fig. 237 and fasten them to the bottom of the box 1 inch from the ends. Use the rim of a breakfast plate in drawing the arc of the rockers.

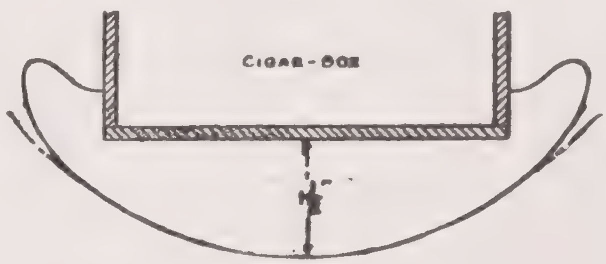


FIG. 237. — Pattern for Cradle Rockers.

**The Key-board** shown in Fig. 238 is one of the simplest gifts that can be made. Follow the dimensions given upon the pattern (Fig. 243) in laying out the board. Where two sides of a piece correspond, first draw a center-line, then lay out one side, trace it off upon a piece of tissue paper, turn the

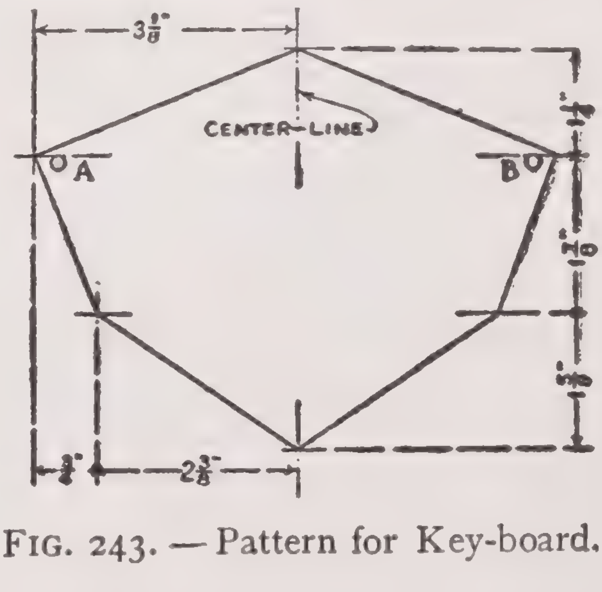


FIG. 243. — Pattern for Key-board.

paper over and reproduce it upon the other side of the center-line. By doing this in laying out all your work you will have no trouble in getting the sides alike. Bore gimlet holes *A* and *B* before cutting out the key board, then there will be little danger of splitting the wood. Space the brass hooks as shown in the photograph.

**The Corner Clock-shelf** (Fig. 239) is built up of several pieces of wood, the shelf (Fig. 244) consisting of

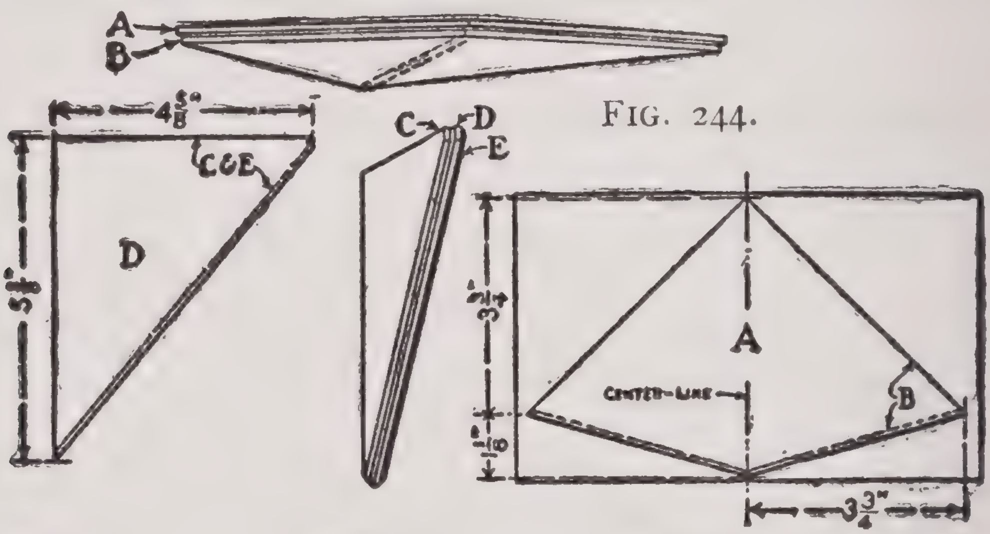



FIG. 247. FIG. 245. FIG. 246.

FIG. 244. — Shelf of Corner Clock-shelf.
FIG. 245. — Bracket of Corner Clock-shelf.
FIG. 246. — Pattern of Shelf Pieces.
FIG. 247. — Pattern of Bracket Pieces.

pieces *A* and *B*, and the bracket (Fig. 245) of *C*, *D*, and *E*. Figure 246 shows the pattern for *A* and *B*. After cutting these pieces trim $\frac{1}{8}$ inch off of the front edge of *B* (see dotted line, Fig. 246). Cover the lower face of *A* and the upper face of *B* with glue, then place them together with the side edges flush and the front

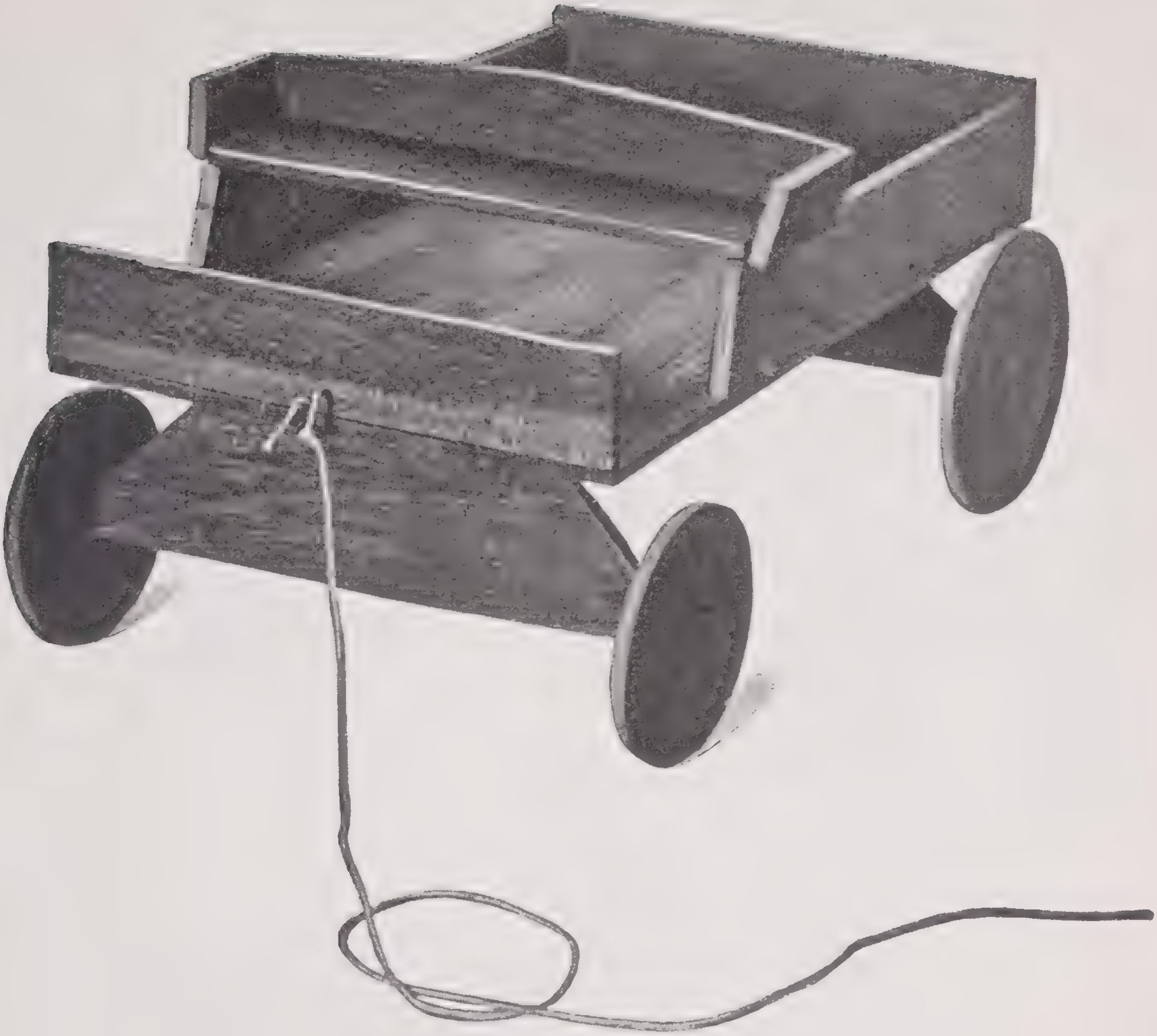


Fig. 223.

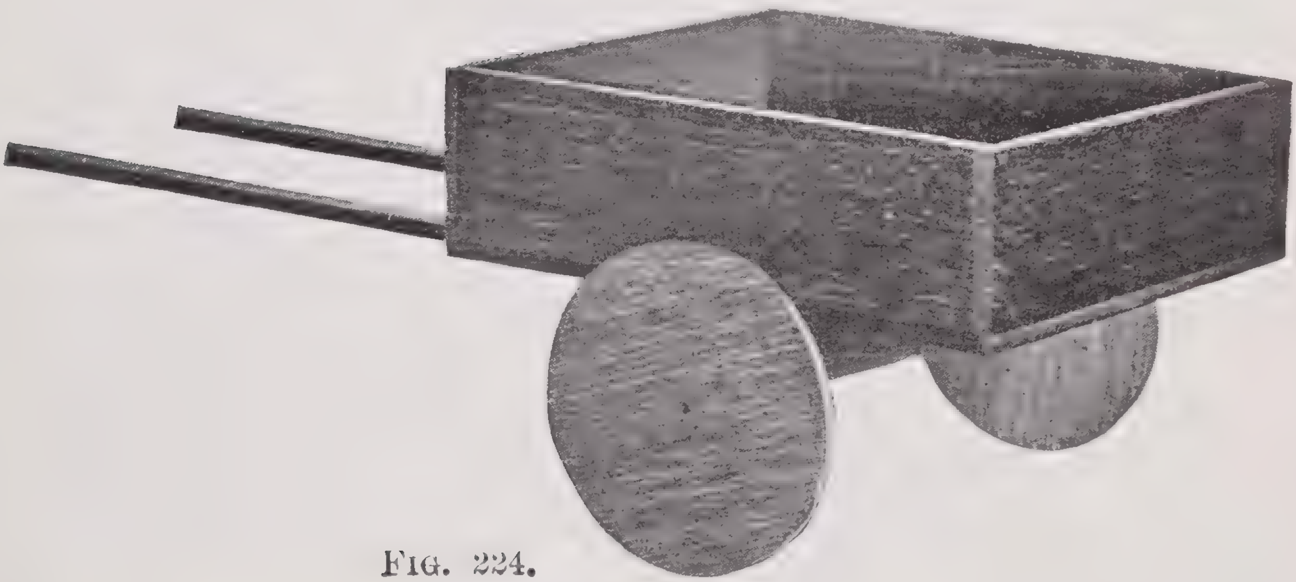


Fig. 224.

Fig. 223. An Express-Wagon.
Fig. 224. A Cart.

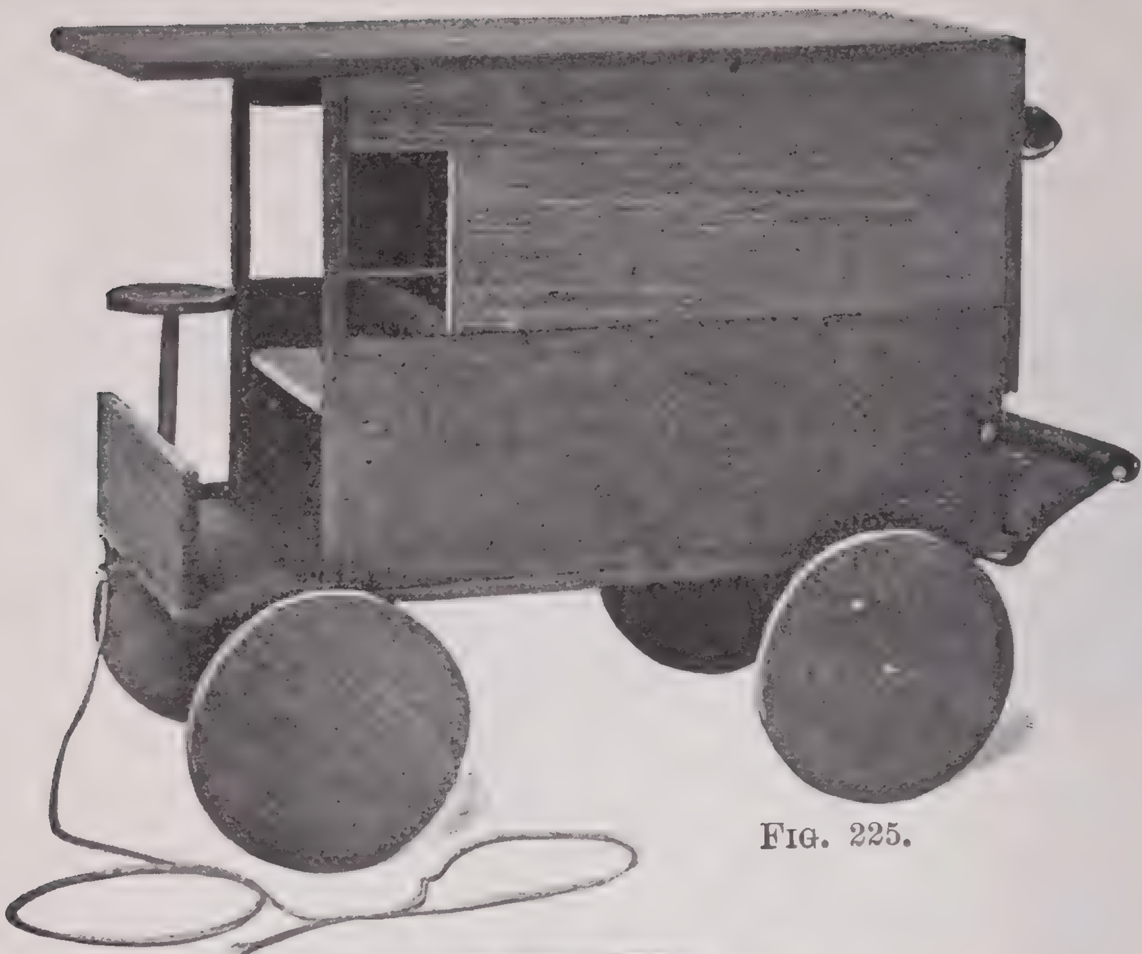


Fig. 225.

Fig. 226.

Figs. 225 and 226. Two Views of an "Auto Delivery-Wagon."

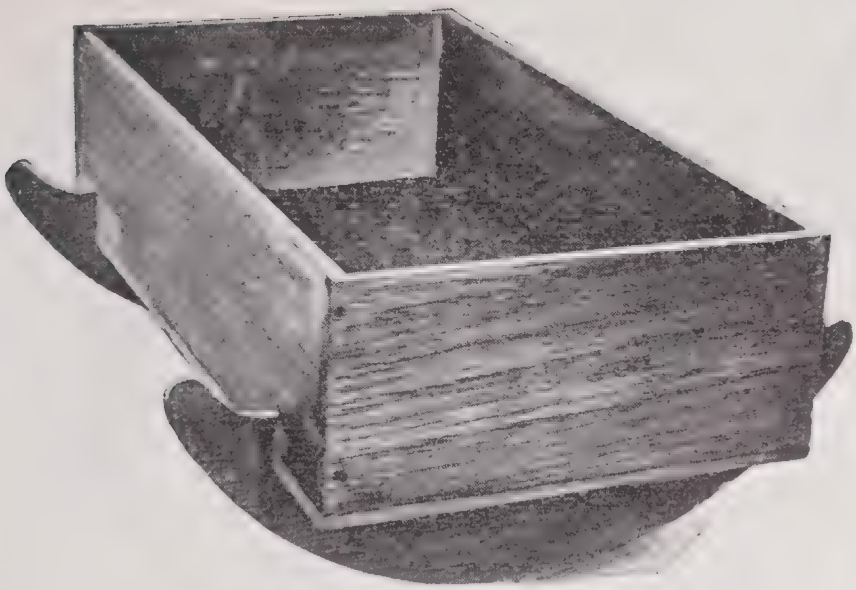


FIG. 234. A DOLL'S CRADLE.

FIG. 230. A ROUND-SEATED CHAIR.

FIG. 228.
A JACK-IN-THE-BOX.

FIG. 231.
A ROUND CENTER-TABLE.

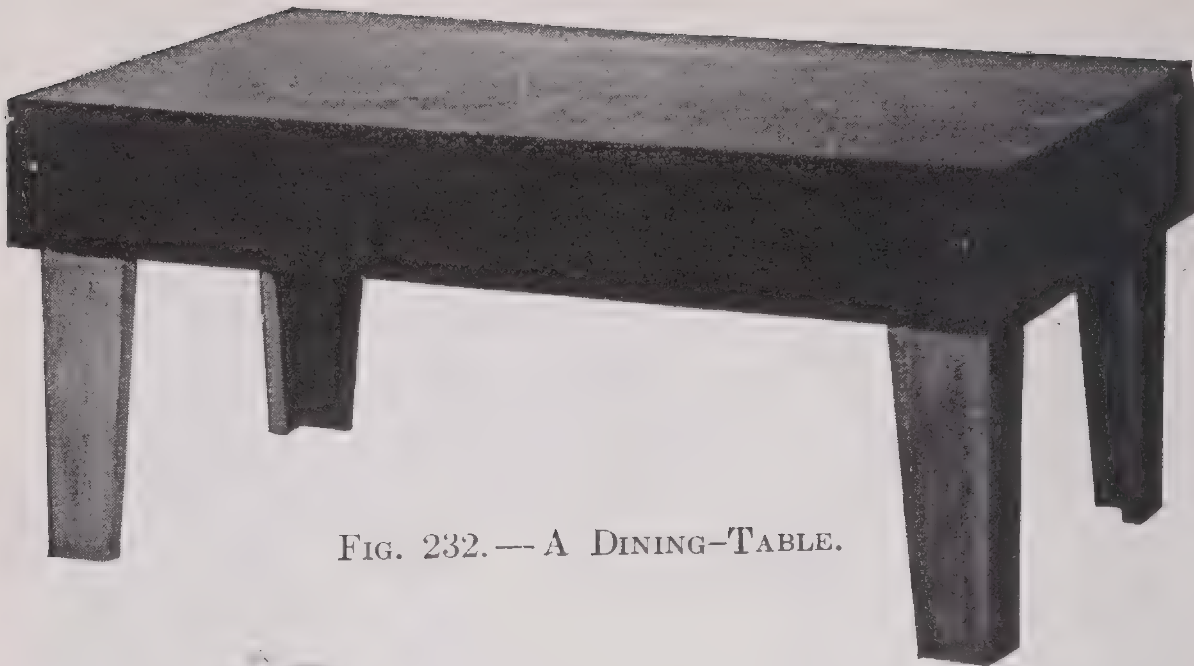


Fig. 232. — A Dining-Table.

Fig. 229. — The Skeleton of the Jack-in-the-Box.

Fig. 233.—A Square-Seated Chair

FIG. 242.

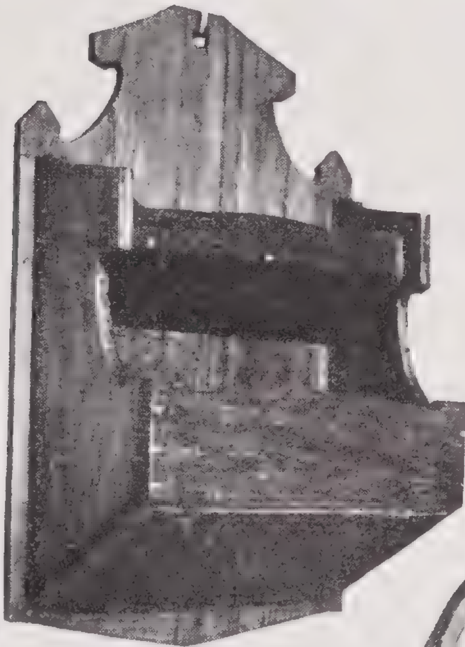


FIG. 241.

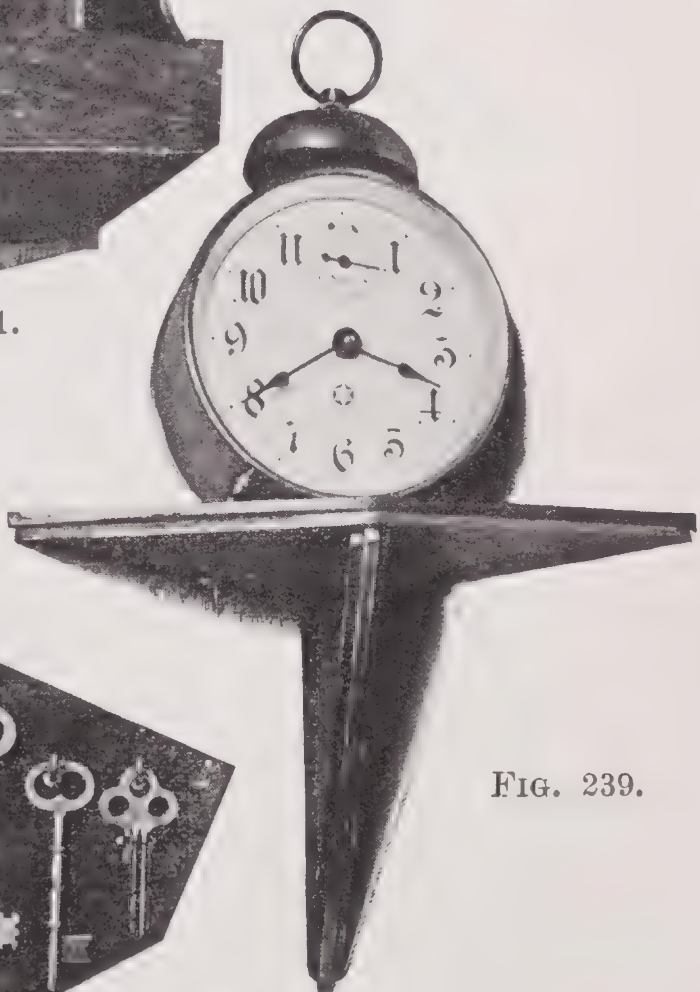


FIG. 239.

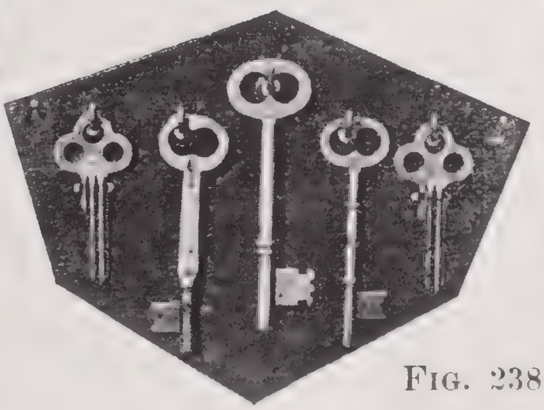


FIG. 238.

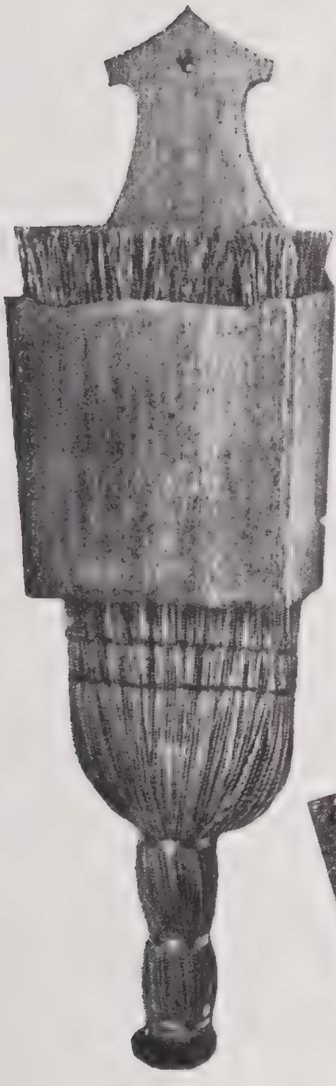


FIG. 240.

FIG. 238. A KEY-BOARD. FIG. 239. A CORNER CLOCK-SHELF.
FIG. 240. A WHISK-BROOM HOLDER. FIG. 241. A KITCHEN MATCH-BOX.
FIG. 242. A COTTAGE PIPE-RACK AND MATCH-BOX.

edge of *A* projecting over that of *B*. Cut the three bracket pieces as shown in Fig. 247, then cut $\frac{1}{8}$ inch off of the long or front edge of *C* and *E* (see dotted line, Fig. 247) so that when they are nailed together the edge of *D* will project beyond *C* and *E* as shown in Fig. 245. The shelf and bracket should be placed under a heavy weight until the glue has set. The photograph shows how to hang the shelf in the corner by means of brads and screw-eyes, the brads being driven into the under side of the shelf and the eyes screwed into the wall for them to stick through.

**A Whisk-broom Holder** such as is shown in Fig. 240 is a gift which any one will appreciate for his or her room. Make the back and front pieces similar to *A* and *B* (Fig. 248) and cut the side pieces $4\frac{1}{16}$ inches high by $1\frac{1}{2}$ inches wide. Place the side pieces between the front and back in putting the holder together.

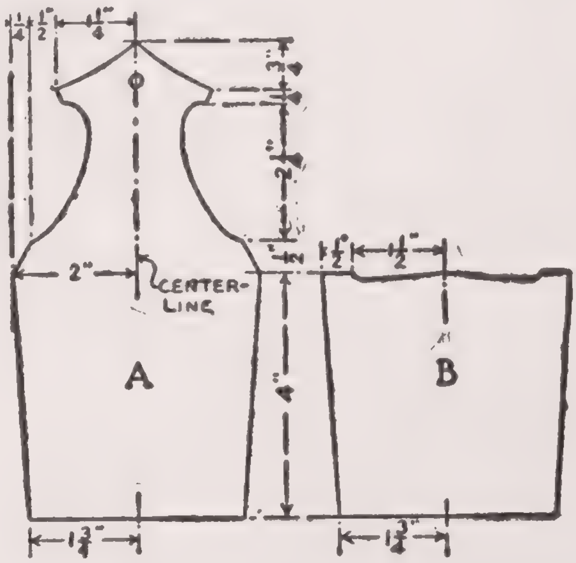


FIG. 248.—Patterns for Whisk-broom Holder.

A large match-box is a very handy article for the kitchen, where the supply of matches generally disappears so rapidly that an ordinary size of box requires refilling every day or so, and

**The Kitchen Match-box** shown in Fig. 241 will be appreciated by your mother, because the large receptacle in

the lower portion will hold a full box of matches. The upper part of the box is intended for burnt matches.

Figure 249 shows the patterns for the different pieces. *A* is the back, *B* the ends, *C* the front of the upper re-

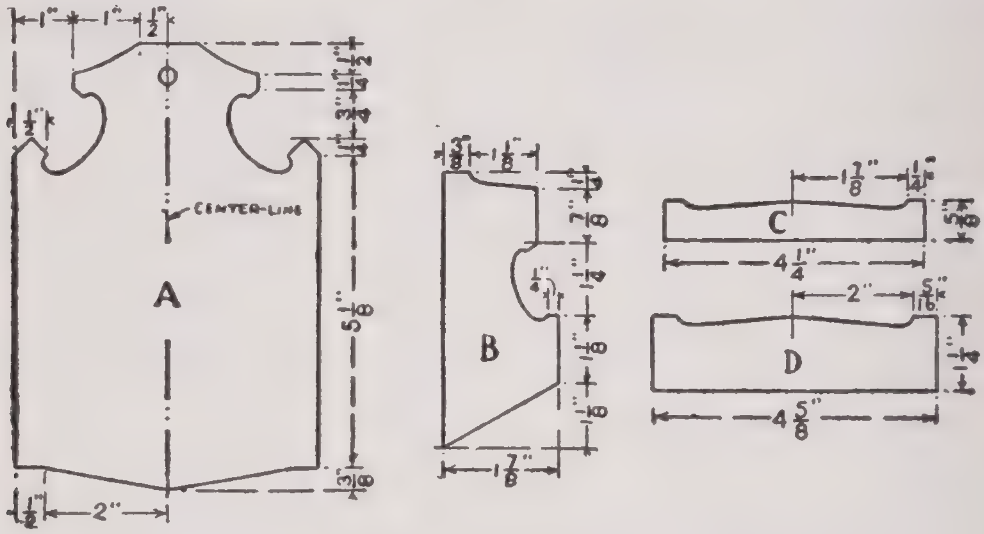


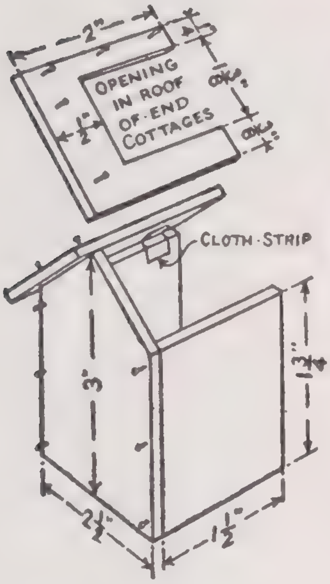

FIG. 249. — Patterns for Kitchen Match-box.

ceptacle, and *D* the front of the lower receptacle. Besides these pieces you will need a piece 1½ inches wide by the length of *C* for the bottom of the upper receptacle and a piece 2¼ inches wide by the length of *D* for the bottom of the lower one. The photograph will show you how to put the pieces together. After the box has been completed and given its oil finish, glue a strip of No. 0 sandpaper to the bottom of the lower receptacle.

A gift suitable for the relative or friend who smokes a pipe is

**The Cottage Pipe-rack and Match-box** shown in Fig. 242. The little cottages are made out of cigar-box wood, but the back and bottom pieces (Fig. 250) are cut out of thicker material; ½-inch pine, whitewood, or basswood will do. Figure 251 shows the dimensions for the cot-

tages and the method of putting them together. As the end cottages are match-boxes, cut an opening in the outer side of their roofs as in Fig. 251. Use glue and $\frac{3}{8}$-inch



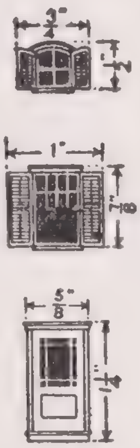



FIG. 252.

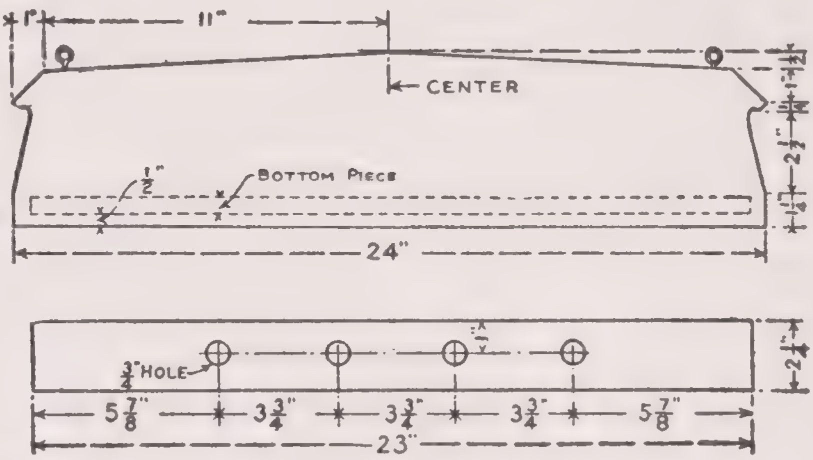



FIG. 250.

FIG. 251.

FIG. 250. — Patterns for Back and Bottom Pieces of Cottage Pipe-rack and Match-box.

FIG. 251. — Details of Cottages.

FIG. 252. — Patterns for Paper Doors and Windows.

brads in fastening the pieces, also cloth strips for attaching the roof.

Give the cottages two coats of linseed-oil, then paint the top and edges of the roofs red (*Venetian red*) and the under side white. With a rule and pencil lay out the doors and windows upon a piece of white letter-paper, then draw the lines in ink, paint the shutters green and the glass black (use *water-colors*), and mark off the divisions in the glass with white; then cut these out and glue them on to the cottages as shown in the photograph.

After the back and bottom pieces have been cut and

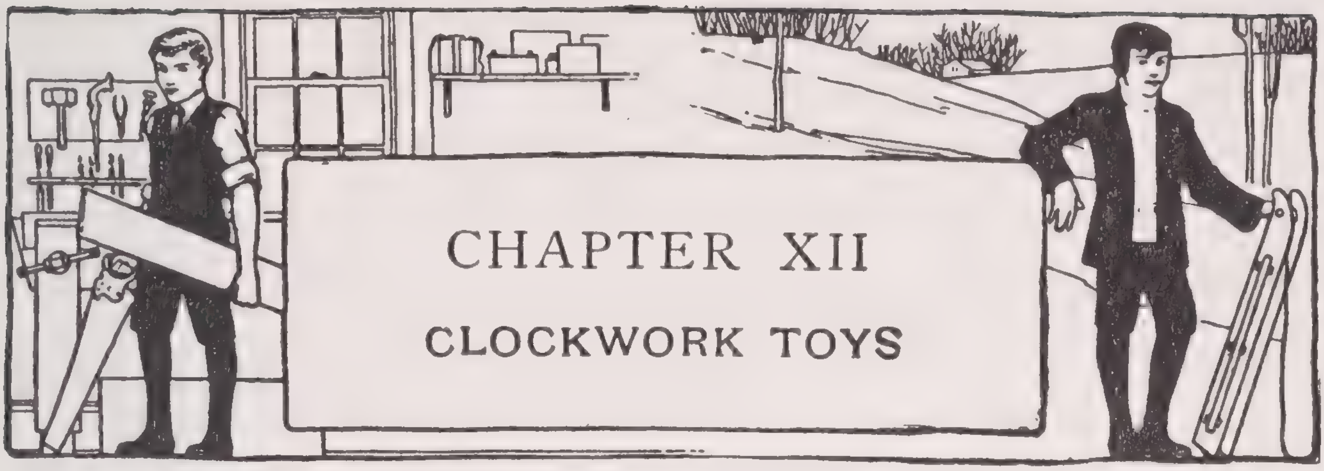
the holes have been bored in the bottom piece (Fig. 250), rub them down with sandpaper and nail the back to the edge of the bottom piece. Give the back piece two coats of *white lead* and *chrome-yellow* (mixed to form a pretty cream color) and the bottom piece two coats of *olive-green.* Glue the cottages in place, spacing them as shown in the photograph, then cut out the little chimneys to fit the roofs, paint them red with white caps (*Venetian red* and *white lead*), and glue them in place. Cut the trees out of a piece of cigar-box wood, paint them green, and fasten them to the back piece with brads. Screw two screw-eyes into the top edge of the back piece and glue a strip of sandpaper below each end cottage on which to strike matches.

Two, three, and four cottage pipe-racks may be made by changing the proportions of the back and bottom pieces, and

**A Cottage Match-box**, made by attaching a single cottage to a back piece similar to *A*, Fig. 249, will be a pretty gift. The cottage may be divided through the center for good and burnt matches, in which case an opening must be cut in each side of the roof.

Among the many

**Other Gifts** which may be made out of cigar boxes are a *letter opener*, a *hall letter-rack*, a cube-shaped *box for string*, a *tooth-brush rack*, a *glove box*, and a *handkerchief box.* Use your ingenuity and work out your own designs for these.



# CHAPTER XII

## CLOCKWORK TOYS

THE toys shown opposite page 190 are a few of the many mechanical toys which can be operated by clock work, and they are easy to make, too, requiring no more mechanical ability than is possessed by the average boy old enough to handle the simplest of tools.

Generally it is easy to find an old clock somewhere about the house, and a clock which has been discarded simply because it has become worthless as a timekeeper is perfectly good for operating these toys, provided the *mainspring* is in working order. It is not necessary to have a set of works for each toy, for they are so quickly fastened in place that but a minute is required to transfer the works from one toy to another.

Before commencing work upon the toys, get together

**The Other Necessary Materials.** These will consist of cigar boxes, cardboard, cotton or silk spools, glue, brads, and a few pieces from the woodpile, with one or two additional articles which are mentioned later on. Brads $\frac{5}{8}$ inch and 1 inch in length should be purchased for fastening the framework of the toys together, and the

cigar boxes should be about 8 inches by 4 inches by 2 inches in size. Remove the paper from the boxes as described in the preceding chapter.

**To prepare the Clockwork** for use, remove it from its case, detach the hands and face, and pry off the small wheel pivoted directly under the hands; this wheel is shown at *A* in Fig. 257. Remove also the *balance-wheel*

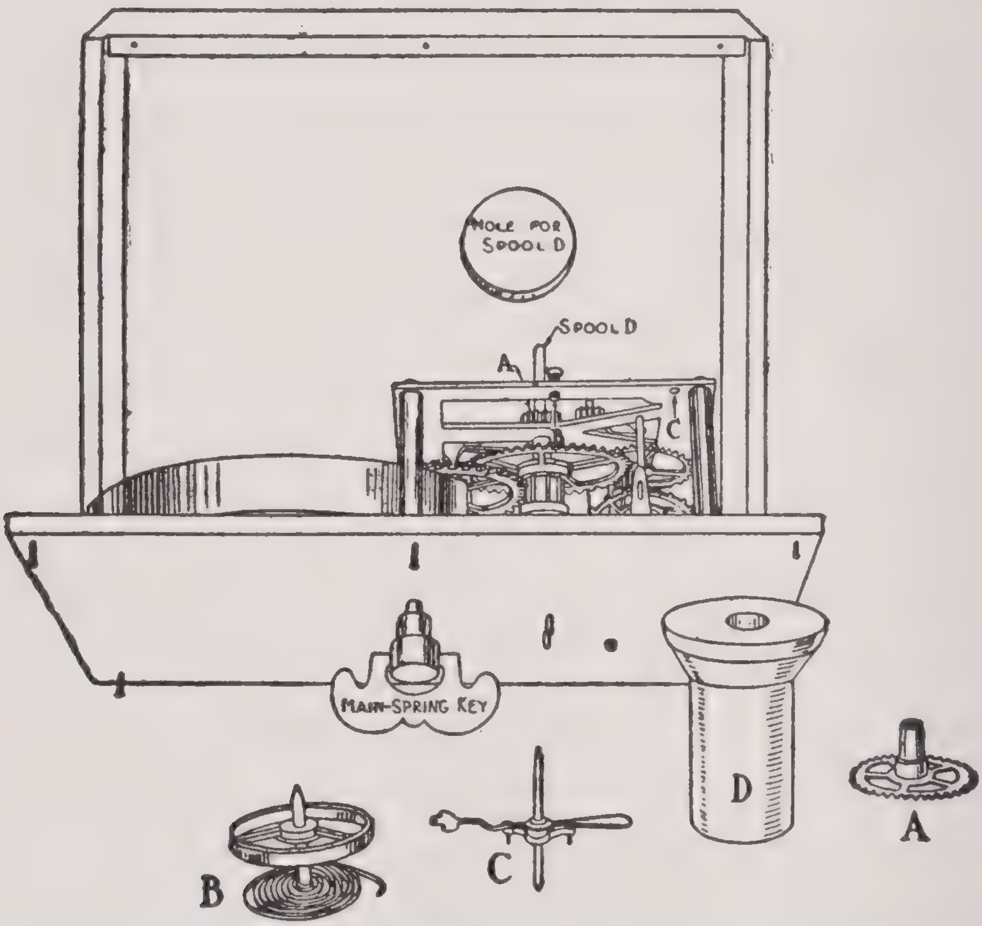



FIG. 257.—How the Clockwork Motor is fastened to the Cigar-box Cover.

(This Box has been cut down to the Proper Length for the Ferris Wheel.)

*B* (Fig. 257) and the *lever C* pivoted next to it, to in crease the speed of the remaining wheels.

Fasten the clockwork motor for

**The Merry-go-round** shown in Fig. 253 to the cover of

a cigar box, as illustrated in Figs. 254 and 257, boring holes through the cover with a gimlet for the *pivot* ends on the back of the works to set into. Remove the lower flange from a spool (*D*, Fig. 257) and fasten the spool on to the central pivot of the clockwork in the position formerly occupied by wheel *A*. The hole in the spool will be too large for the pivot and must be filled up with sealing-wax. To do this, hold a piece of sealing-wax above the spool and melt it with a lighted match, allowing it to drip into the hole until the latter is about half full, then press the wax down with the end of a match until it is compact, smooth it off on the bottom of the spool, and make a dent in it with a pencil to indicate the exact center of the hole. Heat the end of the pivot with a lighted match, and press it into the dent in the wax, being careful in doing so to get the spool straight upon the pivot. Cut a hole through the bottom of the cigar box belonging to the cover to which you have attached the works, for spool *D* to project through (Fig. 257).

**To make the Standard** for the merry-go-round, cut four strips of wood 8 inches long, and fasten one to each corner of the cigar box, turning the bottom side of the box up; then cut a piece of ½-inch board 10 inches square, locate its center *F* by drawing diagonal lines from corner to corner as shown in Fig. 258, bore a 1-inch hole through it at this point for spool *D* (Fig. 254), and then nail the box to the center of the board as shown in Fig. 258.

**The Tent** should be laid out upon heavy white paper as shown in Fig. 259. After describing a circle with a radius of 9 inches, describe another circle within it

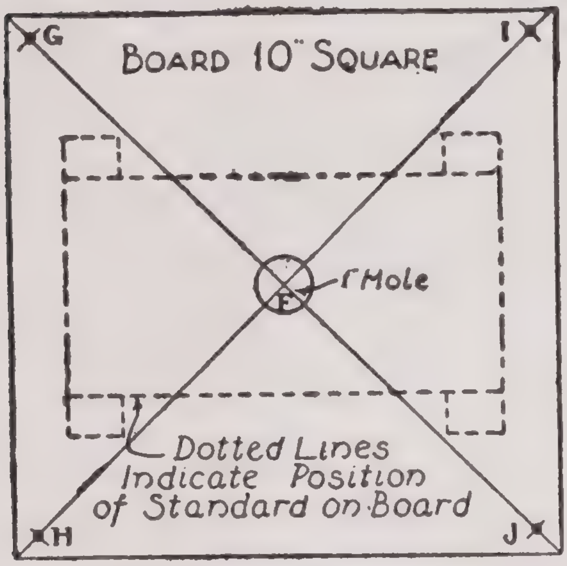



FIG. 258.—Plan of Top of Standard for Merry-go-round.

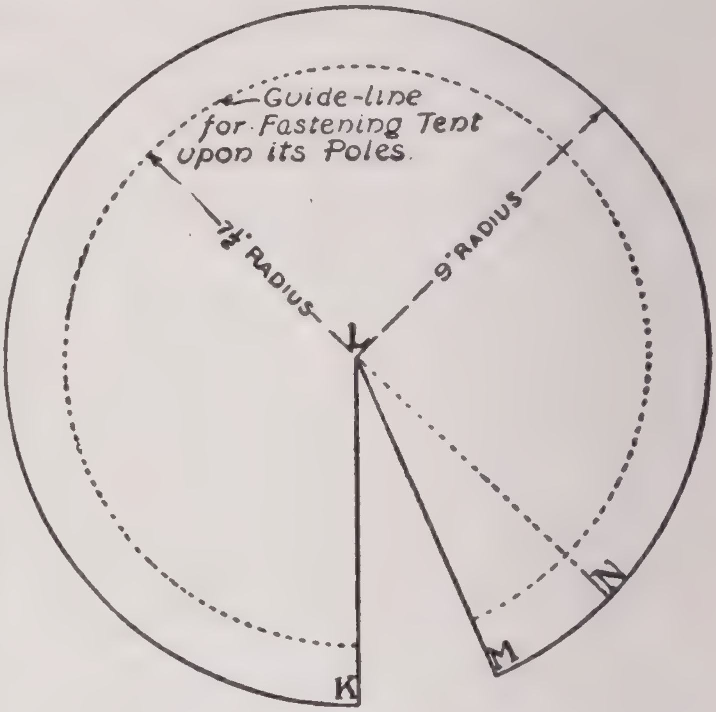



FIG. 259.—Pattern for Tent of Merry-go-round.

with a radius of $7\frac{1}{2}$ inches, this inner circle (shown by dotted lines in the diagram) being drawn for a guide in fastening the tent upon its tent-poles. Cut out the tent along the outer circle, and from it cut a triangular piece about the size of that included between lines *KL* and *ML* in the diagram. Cover the under edge of *KL* and the upper edge of *ML* with glue, lap *KL* over to about *NL*, and rub down the edges with a cloth to make as neat a joint between the pieces as possible (Fig. 260). Bore a hole through each corner of the standard top (*G*, *H*, *I*, and *J*, Fig. 258), then cut four

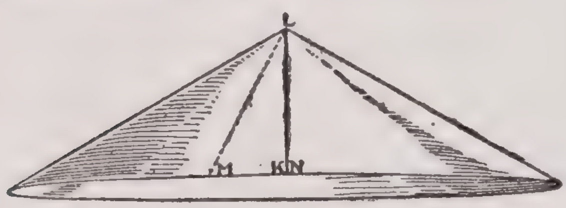


FIG. 260.—The Tent ready to be fastened upon a Tent-pole.

FIG. 253. A MERRY-GO-ROUND.

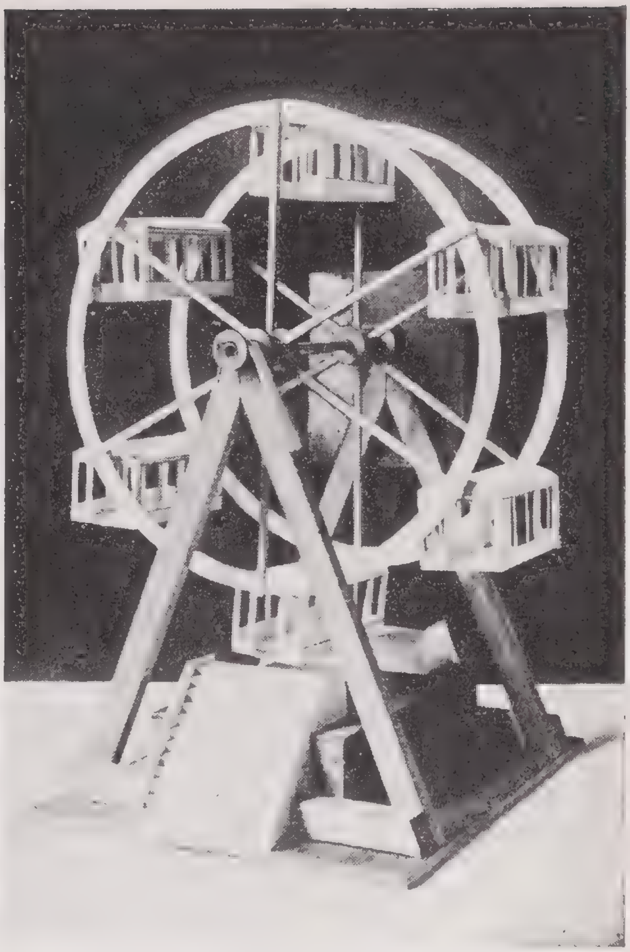


FIG. 255. A FERRIS WHEEL.

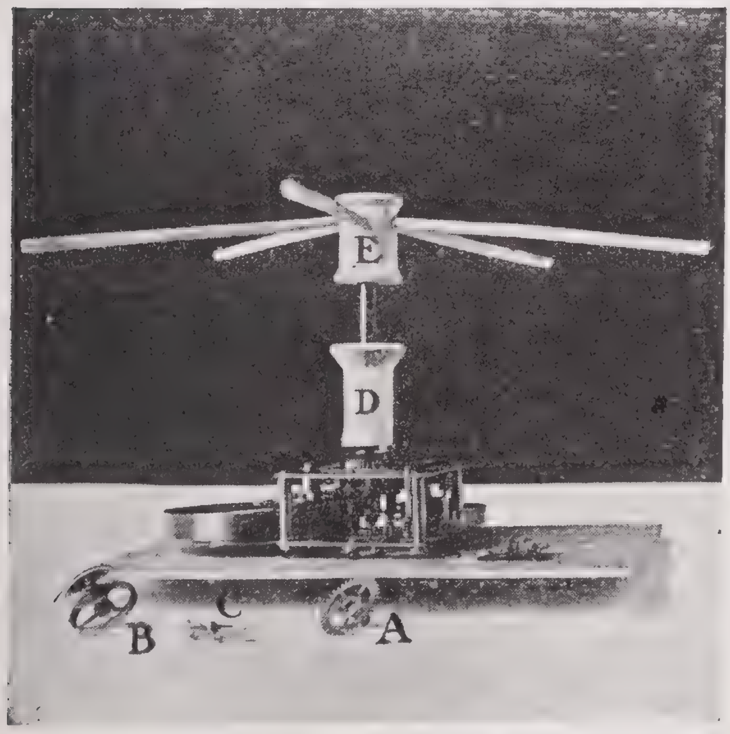



FIG. 254. A CLOCKWORK MOTOR.

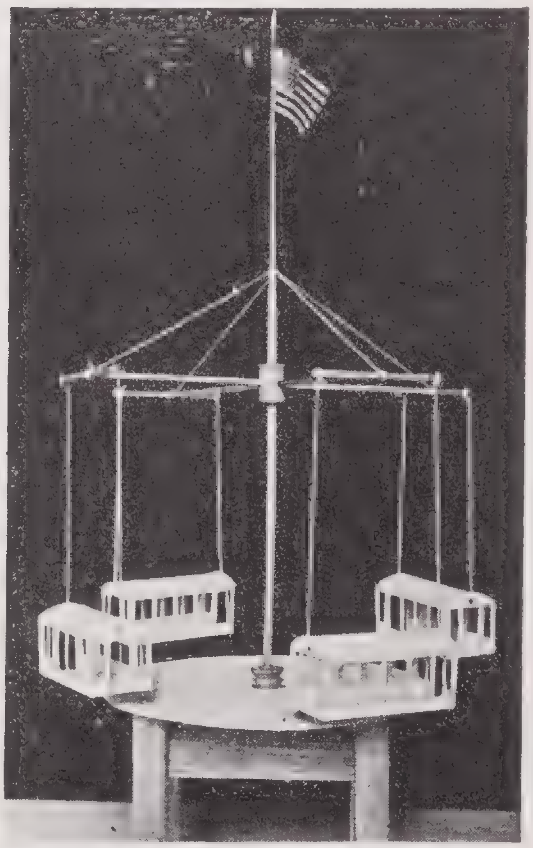


FIG. 256. A FLYING AIRSHIP.

sticks 7 inches long, sandpaper them until smooth, and glue them into these holes for

**The Tent-poles.** When the tent has dried, tack it to the ends of the poles, being careful to make it set evenly upon them; cut a scalloped border out of red or blue paper and paste it to the edge all around as shown in Fig. 253, and stick a small flag in the peak.

**The Horses.** A full-size pattern for these is shown in Fig. 261. Take a piece of *tracing-paper* or any thin

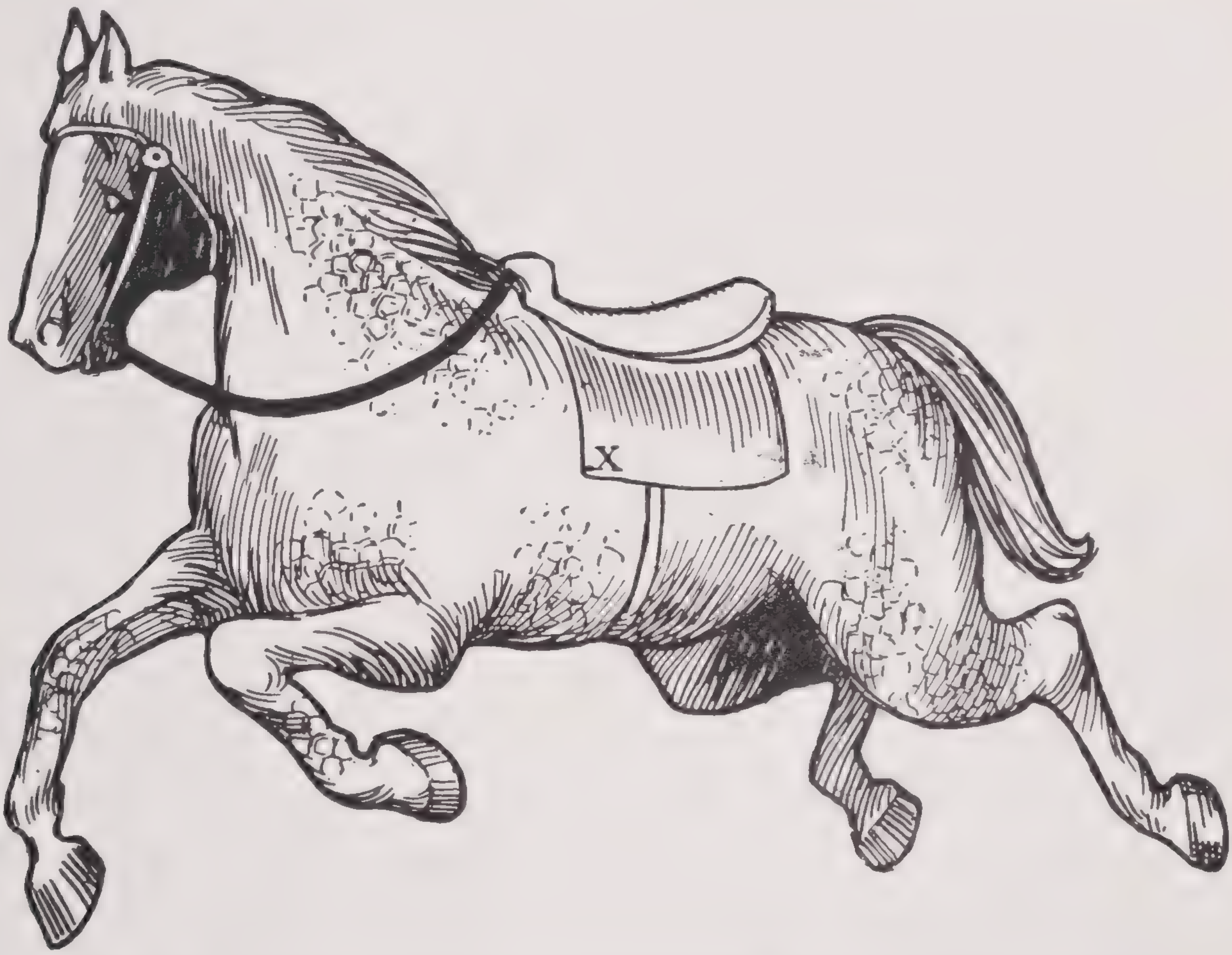



FIG. 261. — Full-size Pattern for the Horses of the Merry-go-round.

transparent paper, and place it over the pattern and make an exact copy; then rub a soft lead-pencil over the other side of the paper, turn the paper over with the

blackened side down, and transfer the drawing six times upon a piece of light-weight cardboard. Paint the horses with water-colors, using the pattern as a guide for shading and marking them, then cut them out with a sharp knife or a pair of scissors.

Figure 262 shows the pattern for

**The Sleighs.** Draw this out upon a piece of cardboard, cut it out and fold along the dotted lines, then turn

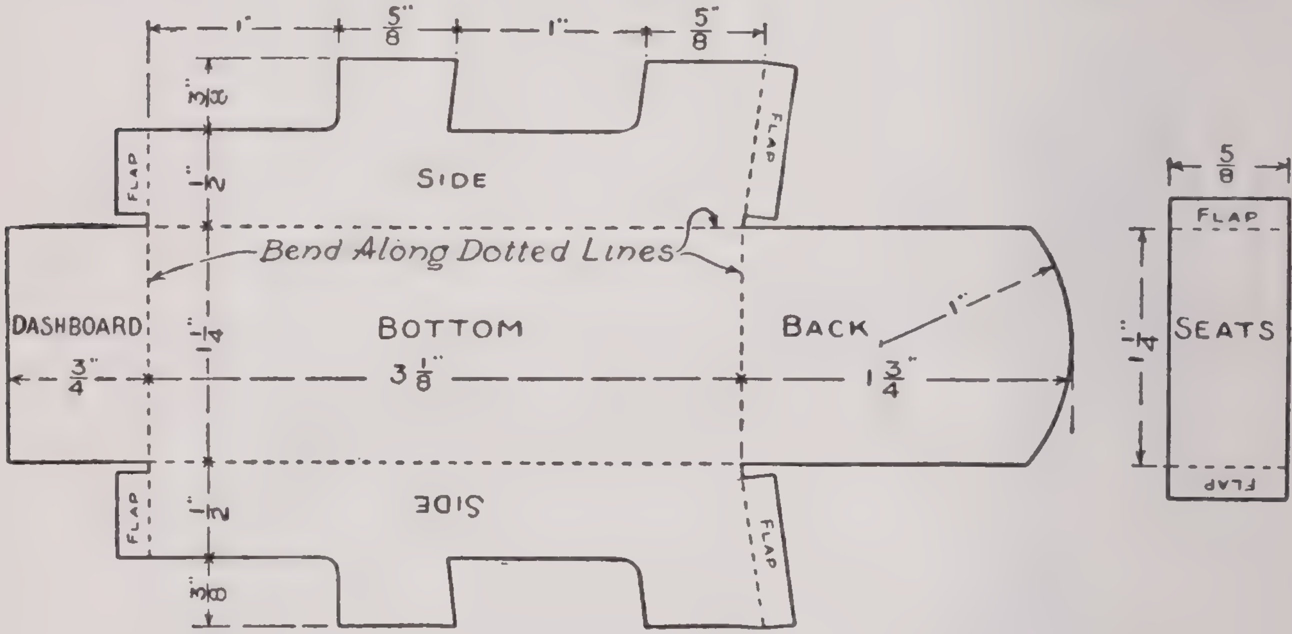


FIG. 262. — Pattern for the Merry-go-round Sleighs.

in the flaps and glue them to the dashboard and to the back. Cut two seats by the pattern given, bend down the flaps and glue them to the sides of the sleigh, and make the back for the front seat like that on the back seat (Fig. 263). Then make another sleigh similar to the one just completed, for two are required for the merry-go-round. Paint the sleighs green or yellow with trimmings of a lighter shade.

Figure 254 shows

**The Shafts** upon which the horses and sleighs are mounted. Cut them $5\frac{1}{2}$ inches long, whittle them round and rub them down with sandpaper. The shafts are fastened in a spool hub which has five holes bored in it (*E*, Fig. 254); bore the holes with a gimlet or small drill, marking them off first with a pencil to be sure of getting them spaced at equal distances. Point the ends of the shafts and glue them into the holes in the hub, then connect this spool to spool *D* with a piece of a lead-pencil 2 inches long (Fig. 254).

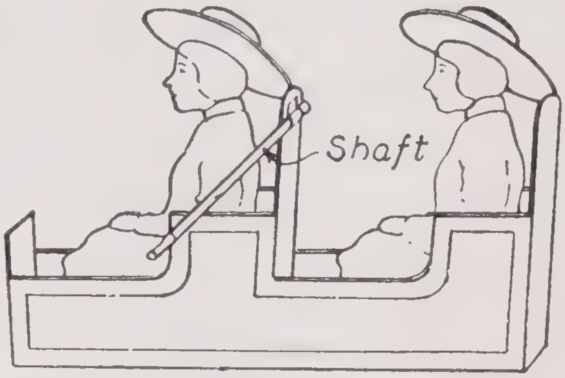


FIG. 263. — A Completed Sleigh showing Attachment to Shaft.

To fasten the horses to the shafts, punch a hole through three of them at *X* (Fig. 261) and slip each one over a shaft, then tack the other three horses to the ends of these shafts at the point *X*. To fasten the sleighs to the remaining shafts, glue one end of a piece of paper to the back of the front seat and the other end around the shaft (Fig. 263).

**The Girl Riders** for the sleighs are shown full size in Fig. 264, and

**The Boy Riders** for the horses are shown full size in Fig. 265. Make tracings from the patterns as you made that of the horse and prepare four girls and six boys. Paint their clothes in bright colors. Cut a second leg for each boy rider, so he can be made to sit astride of his

horse, and glue the leg to his hip as shown in Fig. 266. Cut a slit in each seat of the sleigh and stick the flaps on the girl riders in them.

**For the Platform** shown directly under the horses and sleighs in Fig. 253, cut a piece of cardboard 11 inches in


FIG. 264.

FIG. 264. — Full-size Pattern for the Girl Riders.

FIG. 265.

FIG. 266

FIG. 266. — How the Second Leg of the Boy is Attached.

FIG. 265. — Full-size Pattern for the Boy Riders.

diameter; if you choose to make the Ferris wheel before the merry-go-round, you may use the center pieces removed in cutting out the rims, as noted in Fig. 271. Punch a hole through the center of this disk large enough for the peg connecting spools *D* and *E* to slip through. This platform rests upon the top of spool *D* and revolves with it.

**To operate the Merry-go-round.** The key by which the mainspring is wound up is shown screwed in place on the under side of the cigar-box cover in Fig. 257. While winding the mainspring, it will be necessary to have some means of checking it so it will not unwind at the same time, and the best scheme for a check is to bore a small gimlet hole through the cover of the cigar box and stick a match through this and run it between the spokes of one of the clock wheels so as to prevent it from turning. Then when you have wound up the spring and are ready to start the merry-go-round, all you have to do is to pull out the match.

The model of this toy which the author has before him runs for five minutes with one winding, and any boy can make one which will run as well if he follows the directions given and uses a reasonable amount of carefulness in the work.

**Other Animals** than horses may be used if you wish to follow the arrangement of some of the latest merry-go-rounds, and pictures of these may be found among the colored cut-outs sold in the stationery stores, or if you can draw well, you may copy them from books and magazines. Great fun may be had by changing the positions of the boy riders, making them ride backward part of the time and sometimes two and three boys on a horse.

Doubtless you have heard of the famous Ferris wheel, and a good many of you have ridden in the smaller

wheels patterned after it, at the amusement parks, so you will be interested in making

**A Miniature Ferris Wheel** like the one shown in Fig. 255.

**The Standard** for supporting the wheel (Fig. 267) consists of two triangular supports, one with a spool hub fastened to its top for the axle of the wheel to run through and the other with the cigar box inclosing the clockwork fastened to it. Figures 268, 269, and 270 show the construction of these supports. Cut strips *P* and *Q* 12 inches long and *R* 10 inches long, and trim off the upper ends of *P* and *Q*, so when they are nailed together, the lower ends will be 8 inches apart; nail strip *R* to the lower ends of *P* and *Q* (Fig. 268). To fasten the spool hub to its support, smear one side of a piece of tape with glue and wind it several times around the spool (Fig. 269), then set the spool on top of the support and press the ends of the tape against the sides of strips *P* and *Q* (Fig. 270).

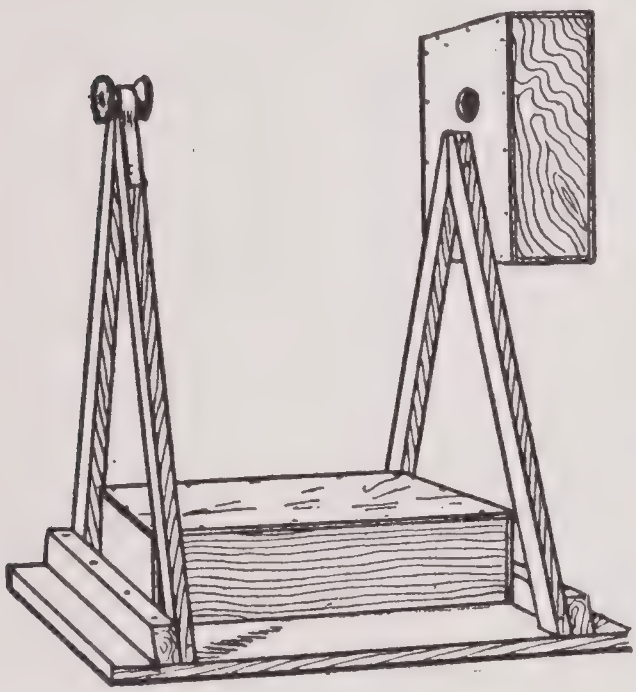


FIG. 267. — Standard for the Ferris Wheel.

**The Clockwork Motor** for the Ferris wheel is fastened to the cover of a cigar box just as that for the merry-

go-round was fastened (Fig. 257), but the length of the box is cut down as much as the clockwork will allow to make the box as square and compact as possible.

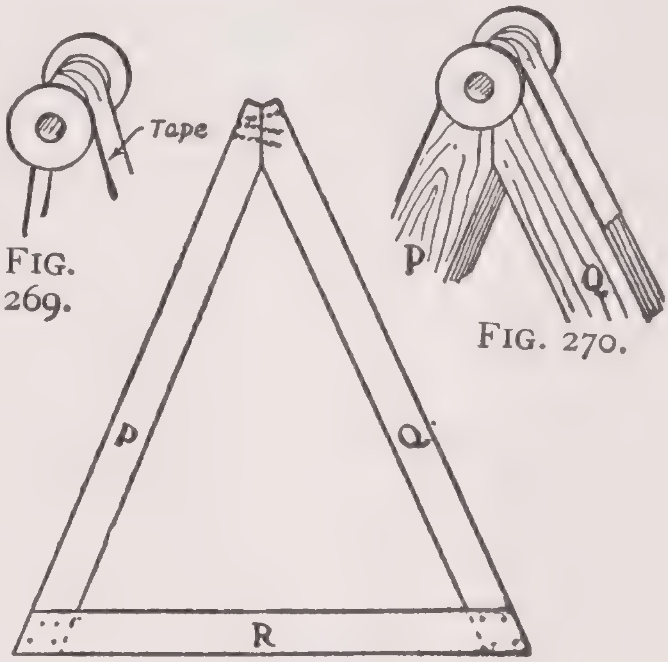



FIG. 269.

FIG. 268.

FIG. 270.

FIG. 268. — Make Two Supports like this for the Ferris Wheel Standard.

FIGS. 269 and 270. — How a Spool is fastened to the Top of the Support for a Hub.

It is very necessary to have the axle bearings exactly on a line in order to have the wheel run smoothly, so, in fastening the cigar box to its support, be sure that the center of the hole in spool *D* (Fig. 257) is on a level with the spool hub on the opposite support. Nail the supports to a 10-inch by 12-inch board, 8 inches apart, and fasten a cigar box between them for

**The Station Platform** (Fig. 267).

**To make the Wheel**, first lay out the rims upon a piece of heavy cardboard, using the radii shown in Fig. 271 for describing the circles, then lay the sheet of cardboard upon a board and

**Cut out the Rims** with a sharp knife, being careful not to run off of the pencil line. The

**Hubs** of the wheel are spools with six holes bored in them for the spokes to fit in (Fig. 274). Cut six

**Spokes** $5\frac{3}{4}$ inches long by $\frac{1}{8}$ inch thick for each hub

and cut a slot in one end of each for the cardboard rims to fit in (Figs. 272 and 275). Use a saw rather than a

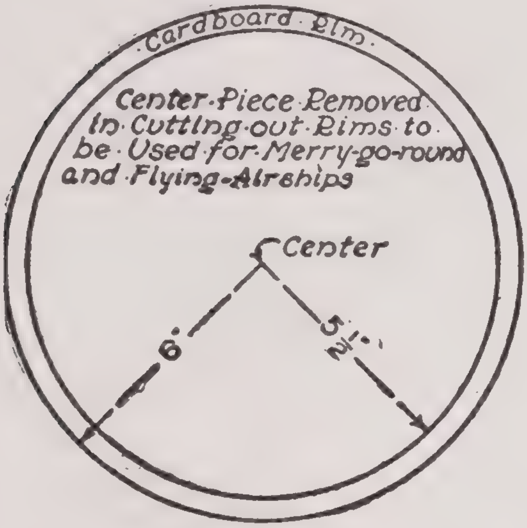



FIG. 271.


FIG. 272.


FIG. 273.

FIG. 271. — How to lay out the Cardboard Rims of the Ferris Wheel.
FIG. 272. — The Spokes fitted into the Spool Hub.
FIG. 273. — The Rim slipped into the End of the Spokes.

knife in making the slots, for it will make a kerf of just the right width to receive the cardboard and will not be so apt to split the ends of the slender spokes. Whittle the hub ends of the spokes to fit the holes in the spool hubs (Figs. 272 and 275). In

FIG. 274. — A Spool Hub for the Wheel.

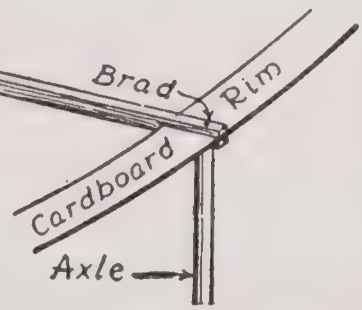



FIG. 275. — How the Spokes, Rims, and Axles are fastened Together.

**Putting together the Spokes, Hubs, and Rims** of the wheel, first stick three spokes in a hub and slip a rim into the slots in their ends, then stick the remaining spokes into the hub, one at a time, and spread the rim enough so it can be slipped into their slots (Fig. 273).

When the hubs, rims, and spokes have been assembled,

lay them aside and get some heavy wrapping-paper or thin cardboard out of which

**To make the Cars.** The pattern for the cars is shown in Fig. 276, and on it you will find all the dimensions

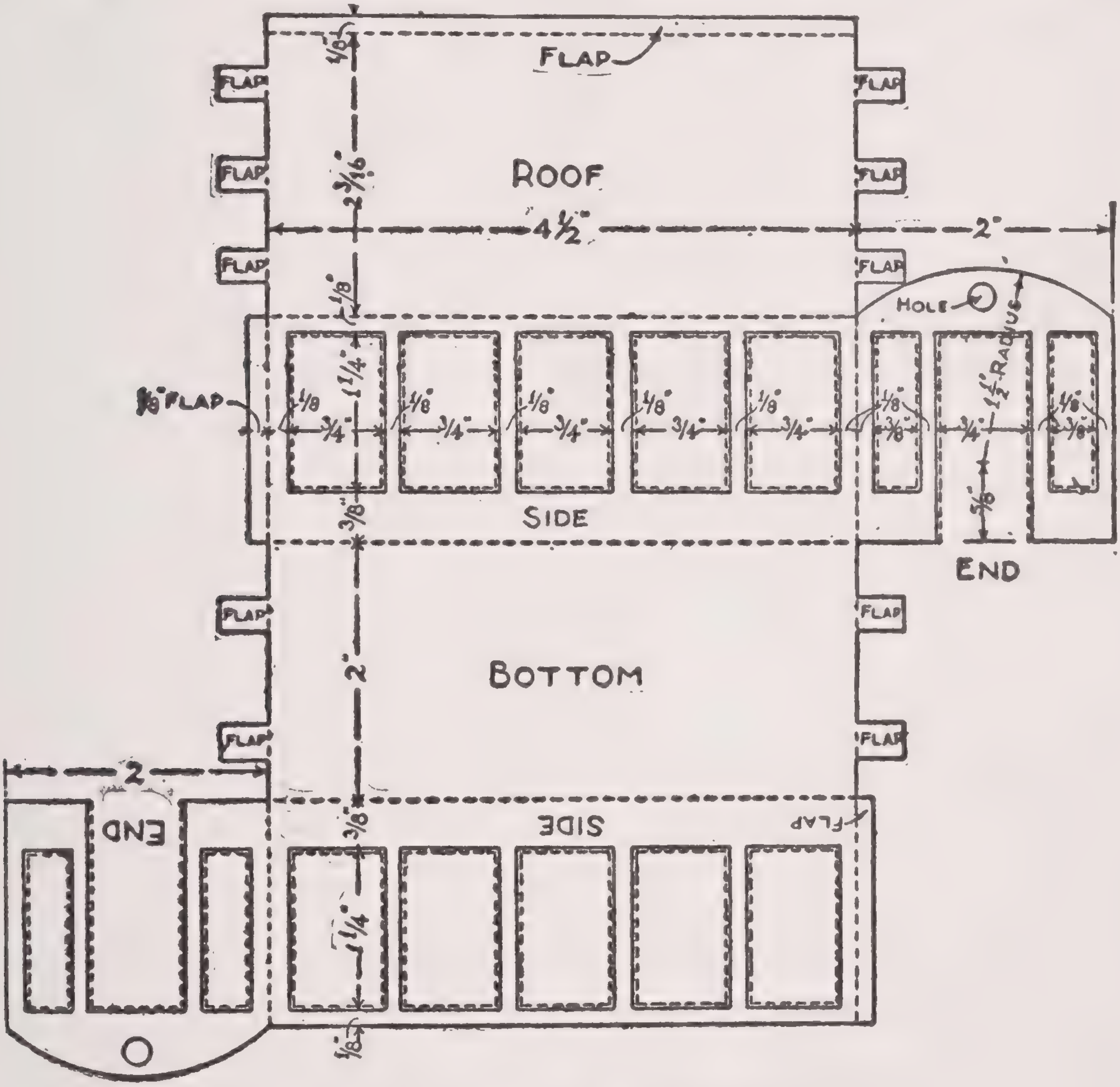



FIG. 276. — Pattern for the Ferris Wheel Cars.

necessary for laying it out to the proper size. It will be understood that the unfigured portions of the drawing are the same as those with dimensions marked upon them. The dotted lines at the door and window open-

ings indicate where the cutting is to be done, while all other dotted lines indicate where the cardboard is to be *scored* and folded. Use a ruler in making the drawing of the car to get the lines straight, and when you have finished it, go over it carefully and compare it with the illustration to be sure it is correct, after which make a careful tracing of it, turn it over and transfer the drawing five times upon cardboard. These and your original drawing will give you the required number of cars. Cut out the openings with a sharp knife and then do the rest of the cutting with a pair of scissors; punch a $\frac{1}{4}$-inch hole in each end of each car with a lead-pencil (Fig. 276), being careful to get the holes exactly opposite.

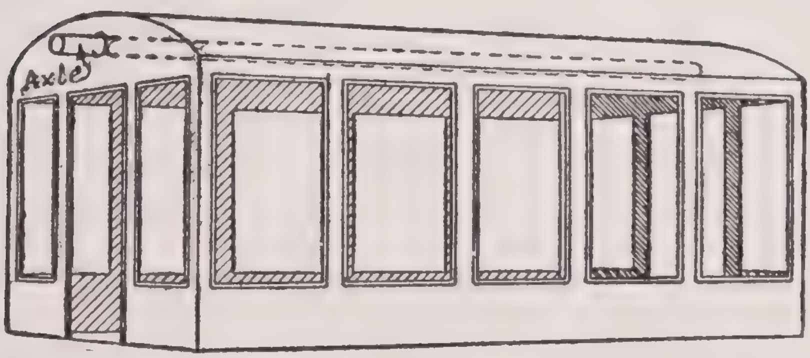


FIG. 277.— A Completed Car for the Ferris Wheel.

In folding and gluing the cars, slip the flaps inside and bend the roofs so they will follow the curve of the ends (Fig. 277).

When the cars have been completed, cut six sticks 5 inches long, whittle them down until they are about $\frac{1}{8}$ inch in diameter, and sandpaper them until they are perfectly round and smooth. These sticks connect the rims of the wheel and form

**The Axles** from which the cars are hung (Fig. 277). Great care must be used in fastening them between the rims, for they are easily split, and the best way to do is

to start a hole first in the ends of each axle with an awl, or by driving a brad part way in and then withdrawing it; then drive a brad through each spoke of one rim into an axle (Fig. 275); slip the other ends of the axles through the holes in the ends of the cars (Fig. 277), and nail the spokes of the other rim to them.

**To mount the Wheel** upon its standard, whittle an axle $8\frac{1}{2}$ inches long to fit the hubs, then hold the wheel between the two uprights, with the hubs on a line with the spool bearings and run the axle through the holes (Fig. 255).

**Build Steps** at each end of the platform out of heavy writing-paper or light cardboard. Fold the paper or cardboard back and forth, making pleats about $\frac{1}{4}$ inch wide, for the steps, and after gluing it in place, cut out the *balustrades* and glue them to the edges of the steps. Make the top step low enough so there will be about $\frac{1}{4}$-inch clearance between it and the bottom of the cars (Fig. 255).

After you have made a final inspection to see that everything has been put together properly, your toy will be ready for operation, and I am sure that when you set the clockwork machinery in motion, and the little wheel begins to revolve slowly with each little car balancing upon its axle, you will agree that you have constructed a very interesting toy.

**The "Flying Airships"** is a riding device consisting of a number of cars suspended by steel cables from large

arms pivoted to the top of a tower. When the machinery is started, the arms begin to revolve slowly, and the motion produced causes the cars to swing out away from the center. As the speed of the arms increases, the cars swing out farther and farther, until when the highest speed has been reached the cables by which the cars are suspended have taken an oblique position and raised the cars some distance above the ground; then the speed of the engine is gradually diminished, and the cars finally regain their former position. This piece of apparatus is also known as an *aërostat.*

You will find the miniature flying airships (Fig. 256) easy to construct after making a merry-go-round or Ferris wheel, as many of its details are identical with those of the other toys.

**The Standard** for the toy is made similar to the one for the merry-go-round (Fig. 253), except that the top board is omitted and a circular piece of cardboard of the size of the disks removed in cutting out the rims of the Ferris wheel is substituted in its place. Cut a hole through the exact center of the piece large enough so it will fit over spool *D* (Fig. 254).

**Cut a Mast** about 14 inches long and of the diameter of the hole in the spool and stick it into spool *D*; then 3 inches below the top of the mast fasten a spool with four horizontal arms 6 inches long glued into holes bored in it. Fasten a cross-piece $4\frac{1}{2}$ inches long to the end of each arm with brads, and from these suspend

**Cars** made similar to those of the Ferris wheel with cords. Set a small flag in a hole bored in the top of the mast and then run cords from the top of the mast out to the ends of the arm pieces.

With this toy the cars cannot be swung out obliquely as on the large flying airships except by

**Increasing the Speed of the Clockwork.** This can be accomplished by removing one or two of the wheels of the clockwork, but it is not advisable to take out more than one wheel in addition to those removed for the merry-go-round (Fig. 257) because the mainspring would require rewinding too often to make the toy enjoyable.

# CHAPTER XIII

## BRASS CRAFT

Of the modern handicrafts requiring materials other than wood, those in which metal is used are probably the most interesting to boys, for metal is one of their principal materials for all work of an electrical or mechanical nature; and as metal handicrafts require tools such as most boys are accustomed to handle, the work is probably better suited to boys than to girls.

Brass-piercing is an interesting metal craft, the material is inexpensive, and the work is simple. Following are

**The Tools and Materials Required:** —

Hammer
Piercing Tool (see Fig. 278)
$\frac{1}{4}''$ Cold-chisel (see Fig. 278)
Flat or Half-round Metal-file (see Fig. 33, page 25)
Board (Whitewood or Basswood) $\frac{1}{2}'' \times 12'' \times 20''$
Pencil, Eraser, and Compass
Drawing-paper and Carbon Paper
No. 30 Gauge Sheet Brass for small work

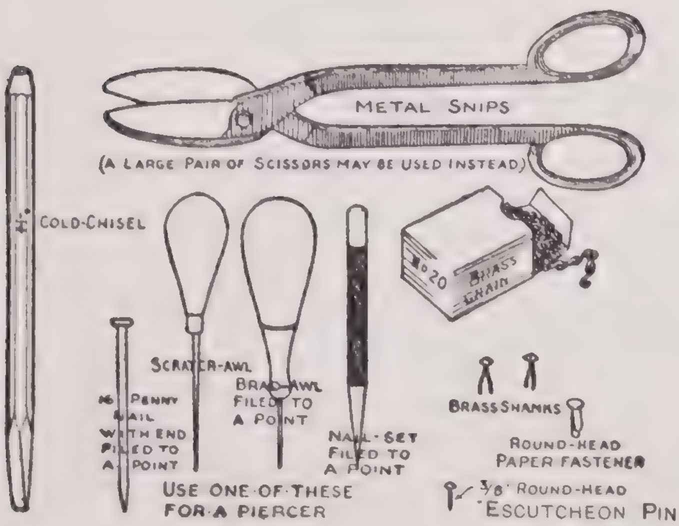



Fig. 278. — Some of the Tools and Materials Required.

No. 28 Gauge Sheet Brass for large work
6-oz. Tacks
$\frac{3}{8}''$ Round-head Escutcheon Pins (Fig. 278)
Brass Shanks or Paper Fasteners (Fig. 278)
$\frac{1}{4}''$ Brass Screw-eyes
Box of No. 20 Brass Chain (or Bead Fringe) (Fig. 278)
Metal Polish and Lacquer

To make easy the work of laying out designs for the articles illustrated in this chapter, suitable designs are shown at a small scale. Those which are more or less elaborate may be drawn full size by the process of

**Enlarging by Squares**, which is easy to carry out. Each of the small squares drawn across these designs represents a space on the full-size pattern $\frac{1}{2}$ inch square (Fig. 281). The first thing to do is to lay out, full size, the outlines and marginal lines of the piece of brass required for the article upon a piece of drawing-paper, using the dimensions given upon the diagram. Take one side of the 12-by-20-inch board for a drawing-board and use the other side to do the piercing on; tack the paper to the board. Then when you have carefully checked up the measurements with those upon the diagram, lay off the squares upon it, making each of those shown $\frac{1}{2}$ inch each way; then number one end of the horizontal lines and letter one end of the vertical lines as shown, and it will be a simple matter to locate each portion of the design upon your pattern just where it is shown in the book, for, by the lettering and numbering, corresponding

squares can be located quickly. When the design has been drawn out full size, it is a simple matter to trace off the entire pattern — outline and design — upon a piece of brass, by placing a piece of carbon paper between the drawing-paper and the brass and then carefully tracing over the lines with a sharp pencil. Carbon paper such as stenographers use upon their typewriters for making duplicate copies of typewritten matter may be used. Where two sides of a design are similar (Fig. 285), enlarge one half, make a tracing of it, reverse the tracing, and trace it off upon the opposite side of the *center-line;* if the design is repeated several times, lay it out upon one section and then trace it off upon the other sections. By doing this it is easier to get all portions alike. Leave a margin of about $\frac{1}{4}$ inch around the edges of the outline to allow for *turning in.* Be sure not to cut out the piece from the sheet until after you have pierced the design, except in cases where the brass is to be mounted upon wood, for the square piece will be easier to hold to the board during this operation.

When ready

**To pierce a Design**, first follow the outlines of the entire design and pierce a continuous row of small holes along them, placing the holes as close together as possible and making them of equal size; then fill in a series of coarser holes in the spaces between these rows of holes to form a background to the design. As the piercing tool is tapered to a point, the size of the hole is, of course, deter

mined by the depth to which it is driven through the brass. Drive the tool with a hammer. The background holes should not be spaced off in even rows nor in the form of a pattern, for the effect would be such as to detract from the design, but they should be scattered over the field in such a way that the spaces between will be about equal; this will give the background an even tone.

Wire brushes are sold for

**Polishing the Brass**, but you will find that any sort of metal polish or scouring powder will answer the purpose very well. Of course the brass will tarnish and must be polished from time to time to keep it bright, unless some finish is put upon it. Brass lacquers — transparent or in color — may be purchased at the art stores, but you will find

**A Home-made Antique Green Lacquer** of the following formula very pretty and a simple solution to make up:—

1 part ammonia muriate
1 part ammonia carbonate
12 parts cold water

The metal should be cleaned thoroughly and the solution should be applied with a brush. Several applications of the lacquer will improve the depth of the finish.

With these general instructions in mind, you can begin work upon some of the simpler articles illustrated in this chapter.

**A Tea-pot Stand** such as is shown in Fig. 279 consists

of a circular wood disk upon which a piece of perforated brass is mounted. Use a piece of $\frac{1}{2}$-inch whitewood or basswood for the disk. Make it $5\frac{13}{16}$ inches in diameter, cut it out with a compass-saw or other fine saw, and smooth the edges with a wood-file or chisel; then sand-paper it. Cut a strip of brass of the proper width and length to form a metal band for the edge of the base, and tack it to the edge with *escutcheon pins* (Fig. 278), spacing them about $\frac{3}{4}$ inch apart.

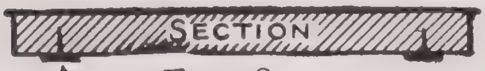



FIG. 280.

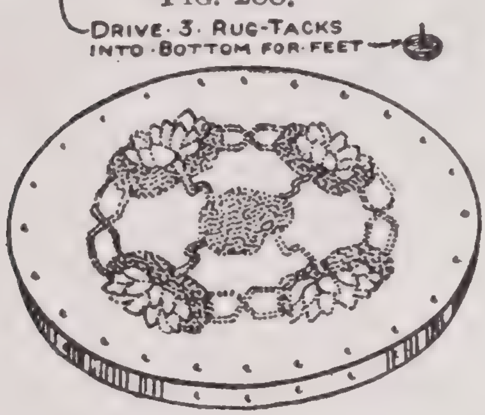



FIG. 279.

FIG. 279. — A Tea-pot Stand.
FIG. 280. — Section through Stand.

The pattern for the top brass covering is shown in Fig. 281. After the design has been laid out full size upon brass, the piece should be cut out before the perforating is done and fastened to the base with escutcheon pins. Describe a circle about $\frac{3}{16}$ inch inside of the edge of the brass, locate positions for the pins around this, $\frac{3}{4}$ inch apart, and punch the holes at these points with the piercer before driving the

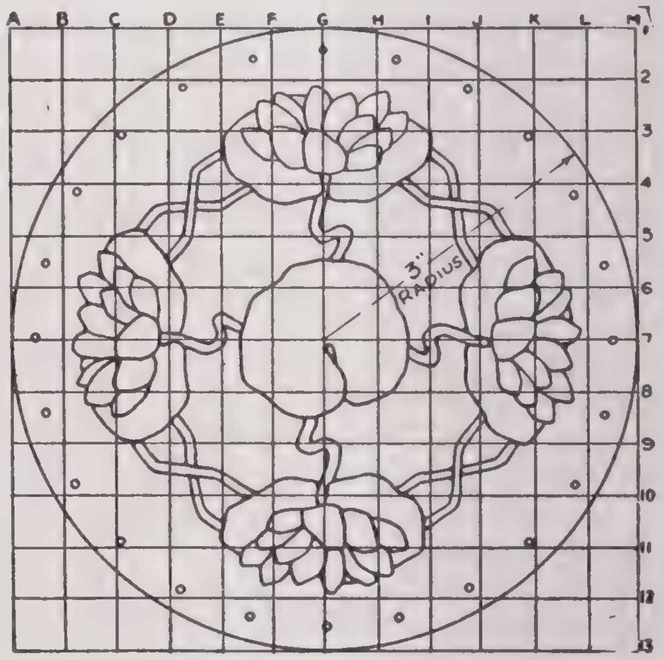



FIG. 281. — Pattern for Top of Tea-pot Stand and Calendar Board.

(On the full-size pattern make each of the small squares shown above ½ inch square, to guide you in enlarging the design.)

pins into the base. The edge of the brass top will project about $\frac{1}{16}$ inch over the brass band (Fig. 280). Drive three rug tacks into the base, as shown, for feet.

**A Calendar Board** like the one shown in Fig. 282 will make a pretty Christmas or New Year's gift. Its construction is similar to that of the tea-pot stand, with the omission of the feet and the addition of a brass screw-eye screwed into the top by which to hang it up. A small calendar can usually be bought at a stationery store, and this should be attached to the exact center of the board by means of two escutcheon pins driven through the corners of the top margin.

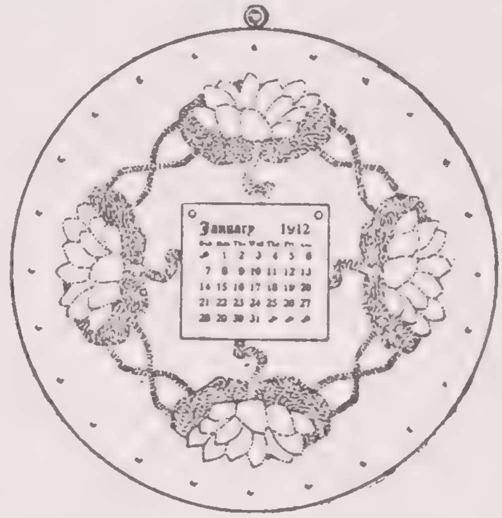


FIG. 282. — A Calendar Board.

**The Pen Tray** illustrated in Fig. 283 requires a bottom block of the size shown in Fig. 284. After preparing

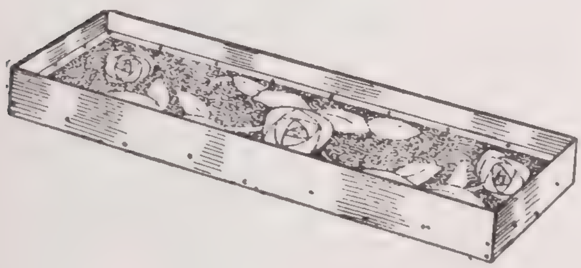


FIG. 283. — A Pen Tray.

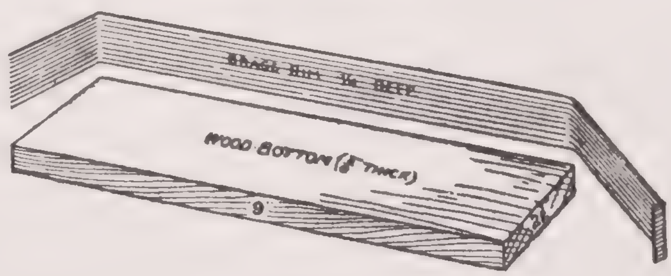


FIG. 284. — Wood Bottom and Brass Rim for the Pen Tray.

this, cut a piece of brass of the exact width and length of the block and fasten it to the top with escutcheon pins, spacing the pins about as shown in Fig. 283. Then en-

large the design shown in Fig. 285, trace it off upon the brass, and perforate it. After this has been done, cut a strip of brass $\frac{3}{4}$ inch wide, bend it to fit around the edge of the bottom block, as shown in Fig. 284, and tack it to the edge to form a rim to the tray. The ends of the strip should be made to lap at one corner as in Fig. 283. File off the top edge of the rim smooth and glue a piece of felt to the bottom of the tray to prevent it from scratching any surface upon which it is placed.

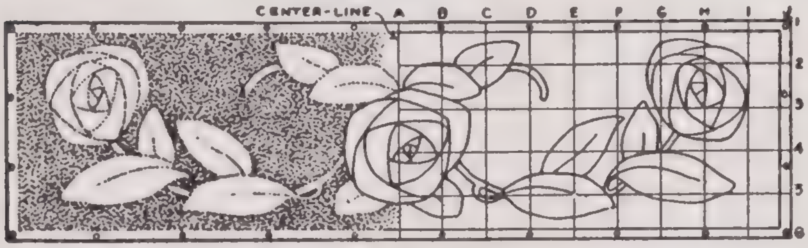


FIG. 285.—Design for Bottom of Pen Tray.
(Enlarge the right half and reverse it for the left half.)

Lamp and candle shades are among the most popular pierced brass articles. Fig. 286 shows

**A Lamp-shade** of six sides, and Fig. 287 how the sides appear when laid out on a sheet of brass. The design is shown upon two of the panels, in the pattern: on one as it will appear when the background is perforated, and on the other with the squares marked off upon it to help you in enlarging it. After laying out the design full size, trace it off upon each of the panels. The piece should be cut out, after the perforating has been completed, and folded along the dotted lines. Bend


FIG. 286.—A Lamp-shade of Six Sides

the brass over the sharp edge of your board. The flaps along the top and bottom edges should be turned in and

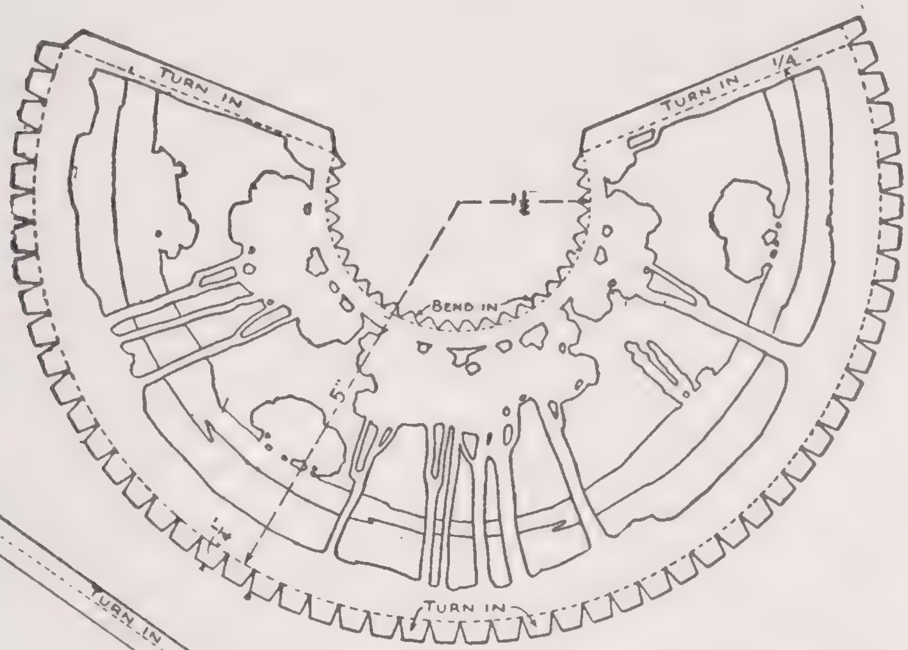



FIG. 288. — Pattern for Circular Candle-shade.

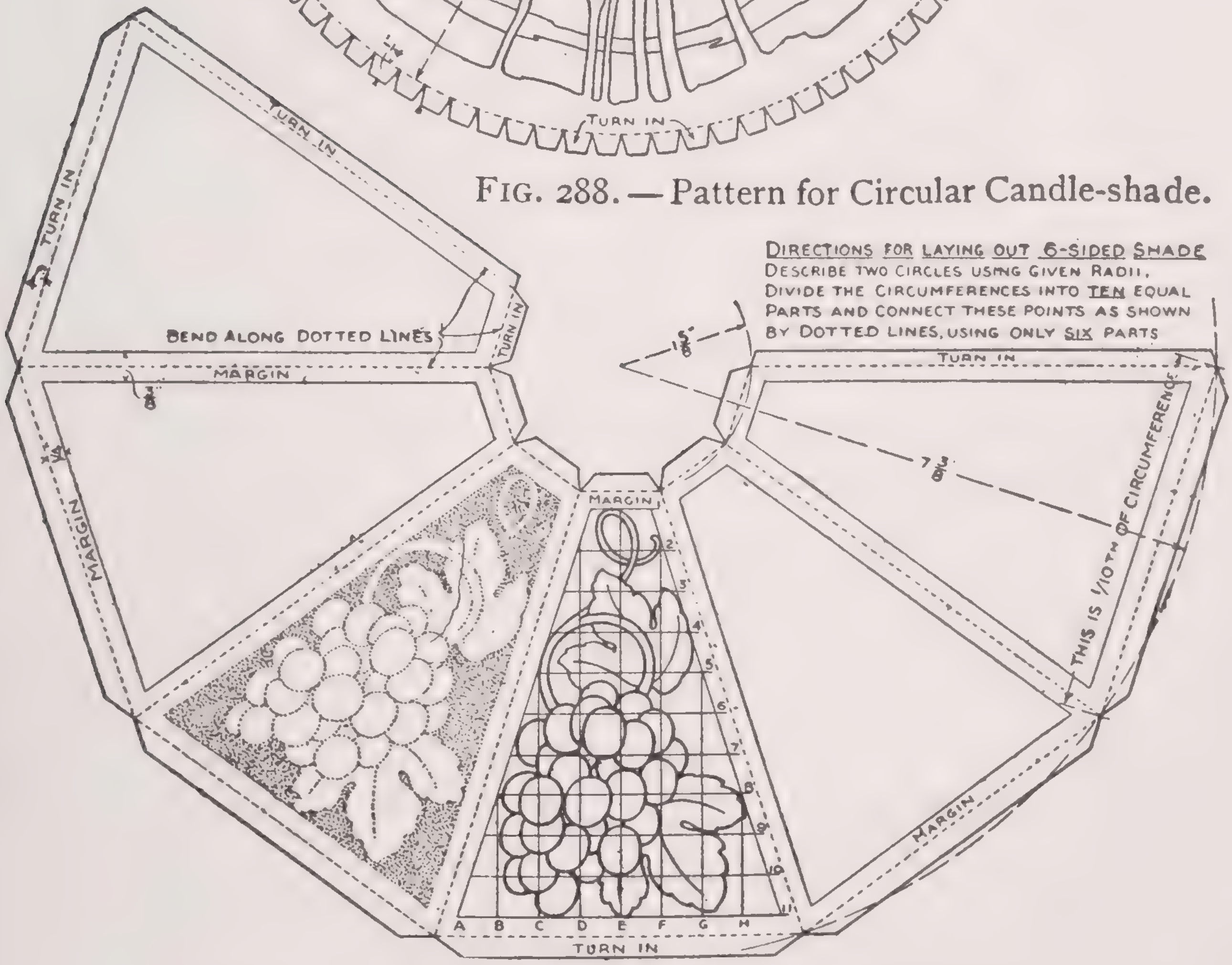



FIG. 287. — Pattern for Lamp-shade of Six Sides.

hammered flat against the sides of the shade, and the end edges should also be turned in and one lapped over

the other. Fasten the end edges with brass shanks, paper fasteners, or escutcheon pins (Fig. 278), bending the ends over upon the inside. If you use the pins, cut them off short and clinch them upon the inside by placing them on the head of a hatchet and hammering the heads with a hammer.

**Chain Fringe** is cheaper and more interesting to put on than the bead fringe frequently used upon brass shades. Figure 278 shows the size which should be bought. Cut this up into 3-inch lengths and fasten the pieces to the lower edge of the shade about $\frac{3}{16}$ inch from center to center, hooking the opened link on the end of each piece of chain through a hole punched through the brass, and then pinching it closed.

**The Candle-shade** on the candle-stick in Fig. 291 should be laid out by the pattern in Fig. 288. As the landscape design is very simple, it will not be necessary to enlarge it by squares. After piercing and cutting out the piece of brass, snip the top and bottom edges, cutting out small triangular pieces as shown, and then bend over the little flaps thus formed and hammer them down flat against the inside face of the shade. The edge of one end of the piece should also be turned in (see dotted line on pattern), and this should either be lapped over the other edge and the two fastened as described for the other shade, or the other edge should be folded out and one edge hooked into the other as the edges of a tin can are joined, and the two hammered down so as to make

a neat edge. Attach chain fringe to the rim as described for the other shade.

Figures 289 and 290 show two forms of

**Shade Holders**, the former for an electric lamp and the latter for a candle. These can be bought where light-fixtures are sold and cost about 10 cents apiece.

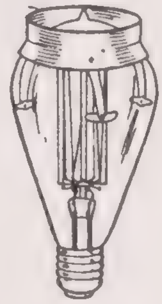


FIG. 289.

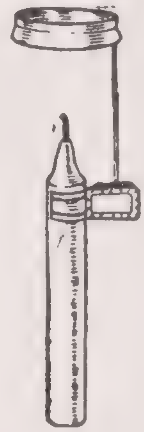


FIG. 290.

FIG. 289.—Electric Lamp-shade Holder.

FIG. 290. — Candle-shade Holder.

**The Candle-stick** shown in Fig. 291 is easy to make, and when the wood is carefully covered with the brass, makes a very neat-appearing article. Figure 292 shows the sizes of the pieces of brass, together with the designs which are to be perforated upon them. First prepare the wood blocks for the base, upright, and top pieces, making them $\frac{1}{16}$ inch less than the dimensions given upon the patterns, to allow for the thickness of the brass. Before fastening the blocks together, prepare the brass pieces, nail them in place, lay out the designs, and perforate them. The sides should be made in one

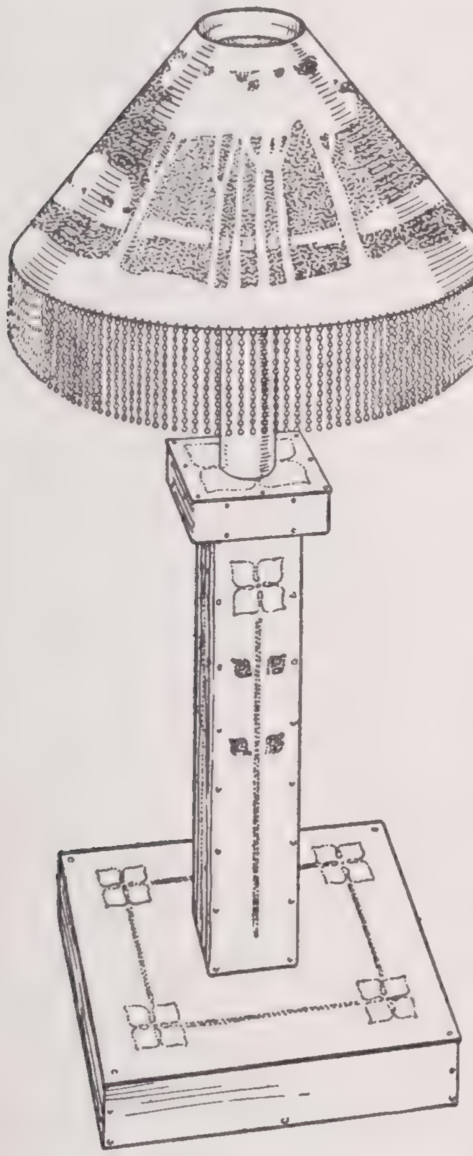


FIG. 291. — A Brass Candle-stick with Circular Shade.

piece and be bent around the corners. The upper covering of the top and base pieces should project about $\frac{1}{16}$ inch

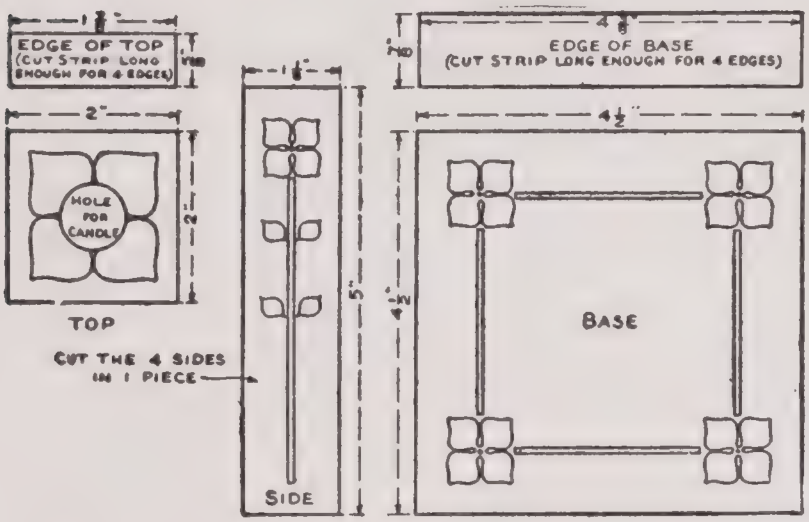



FIG. 292. — Patterns for Brass Pieces of the Candle-stick.

(Cut the *wood blocks* $\frac{1}{16}$ inch less than the above dimensions to allow for the thickness of the brass.)

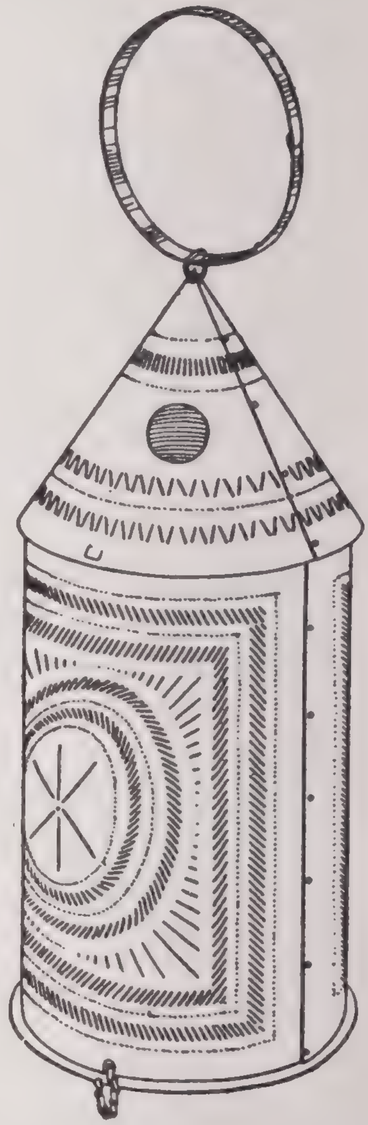


FIG. 293. — A "Paul Revere" Lantern.

as shown in Fig. 291. After nailing the blocks together, glue a strip of felt to the bottom of the base piece.

**The "Paul Revere" Lantern** shown in Fig. 293 differs from the lanterns used in the colonial times only in this respect — it is lighted by removing the bottom instead of through a doorway in the side. The door has been omitted to make the construction simpler; however, if you wish to make an exact copy, you may make a door and hinge it in place with pieces of wire. For this lantern the proper size for an opening would be $3\frac{1}{2}$ by $6\frac{1}{2}$ inches.

The right-hand portion of the patterns for the side

and top pieces (Figs. 296 and 297) shows the main measurements for the design, and at the left the design is shown perforated. After laying out lines to the measurements given, divide up the spaces between into the number of spaces shown. The small holes of the design are made with a piercer, and the slits are cut with a cold-chisel (Fig. 278). Space the perforations as shown, and be careful to keep the ends of the slits within the guide-lines

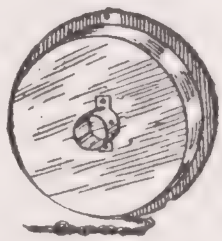


Fig. 295.—The Lantern Bottom.

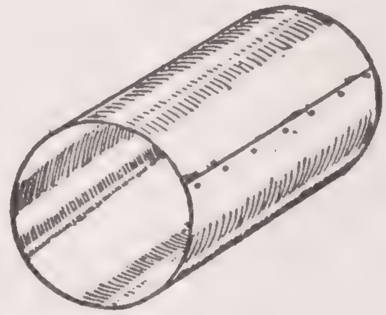


Fig. 294.—The Lantern Sides.

The tips on the upper edge of the side piece slip through the slots cut in the top piece (Figs. 296 and 297), and hold the top to the sides when bent over, while the two holes near the bottom edge are made to receive the pins which hold the bottom in place (Figs. 293, 294, and 295).

Fasten the ends of the side piece together with brass shanks (Fig. 294), then cut a circular block of wood to fit in the bottom end of this cylinder (Fig. 295), and fasten to it a circular piece of brass of a large enough diameter to make a $\frac{1}{4}$-inch projection beyond the sides of the lantern. Make a candle-holder out of a strip of brass, as shown in Fig. 295, and tack this to the base block. The pins for holding the bottom in the lantern are made out of two brass screw-eyes,

by filing off the threads, and these are held to the bottom with short pieces of brass chain to keep them from being lost when the bottom is removed for lighting the candle. Before fastening the top to the sides

FIG. 297.

FIG. 298.

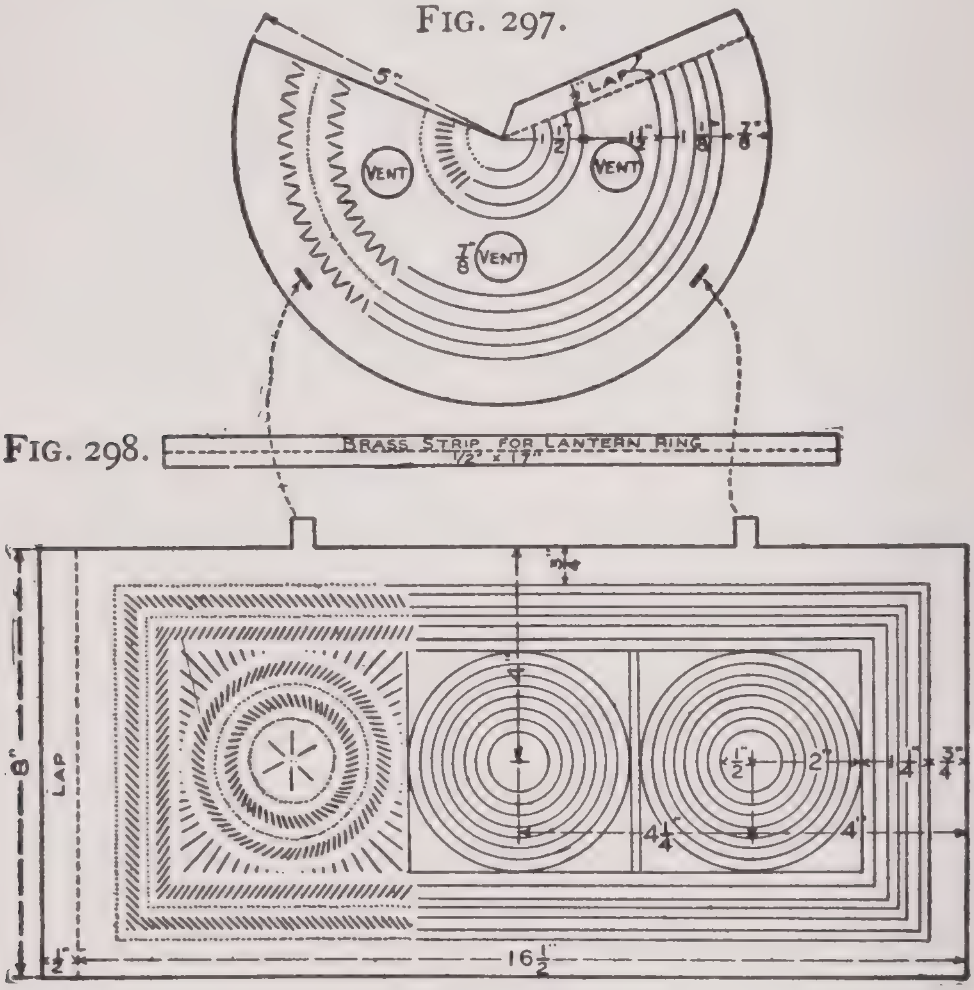
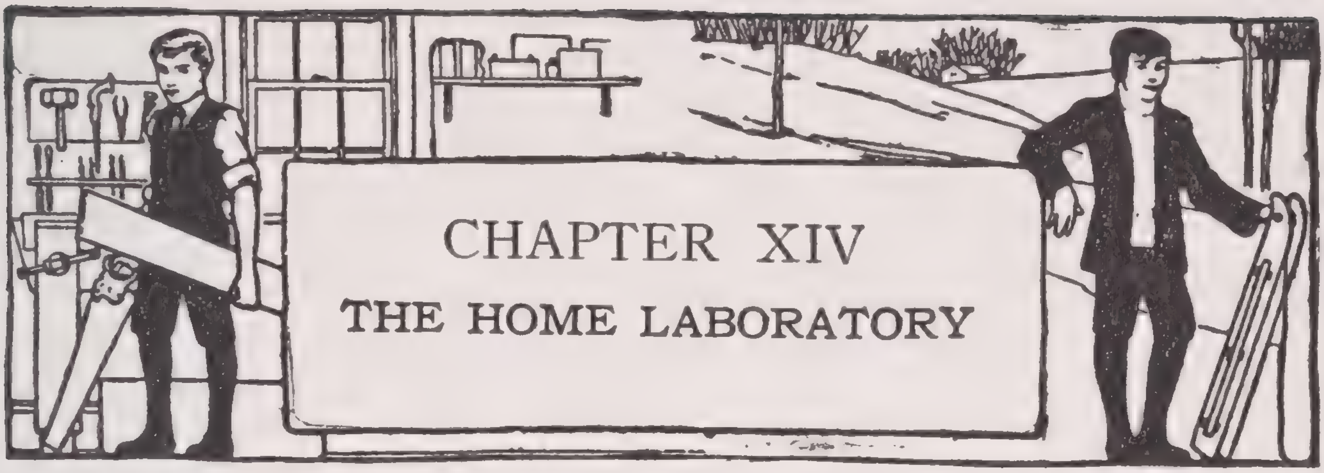



FIG. 296.

FIG. 296. — Pattern of Lantern Sides.
FIG. 297. — Pattern of Lantern Top.
FIG. 298. — Brass Strip for Lantern Ring.

prepare the lantern ring. Cut a strip of brass of the size shown in Fig. 298, bend it over along the center to make it stiff, and then bend it into a ring and clinch the ends together like the sides of a tin can are clinched. Wire the ring to the peak as shown in Fig. 293.



# CHAPTER XIV

## THE HOME LABORATORY

MAYBE you have fitted up a "lab" in the basement, combining it with your workshop. Well and good. Some boys, however, prefer to have the lab upstairs in their room, realizing that this location affords greater opportunity for concentration upon theories and experiments set down in the text books and technical magazines that must play an important part in their lab program. A table and a chair or stool are two essential pieces of lab equipment. Figure 325 shows a table with a large top suited to the purpose. Plans for building it are given in Chapter VI. A small vise clamped to one end, and a rack across the back for files, drills, screw-drivers, pliers and other small tools, will organize the table for simple tool work and assembling.

Before the advent of radio and the broadcast of programs, every boy was interested in wireless telegraphy. It was his fondest dream to own and operate an amateur wireless telegraph station. Going back a generation further, it was the height of a boy's ambition to own a telegraph station. Today, with better materials and

more data than were obtainable in the past, it is within the range of possibility for any boy to own a telegraph, wireless, or radio station, or all three, provided that he can comply with government regulations for the latter and can qualify for an amateur operator's license. Since the regulations and qualifications are subject to revision, they are not presented here. They may be obtained from the supervisor of your district.

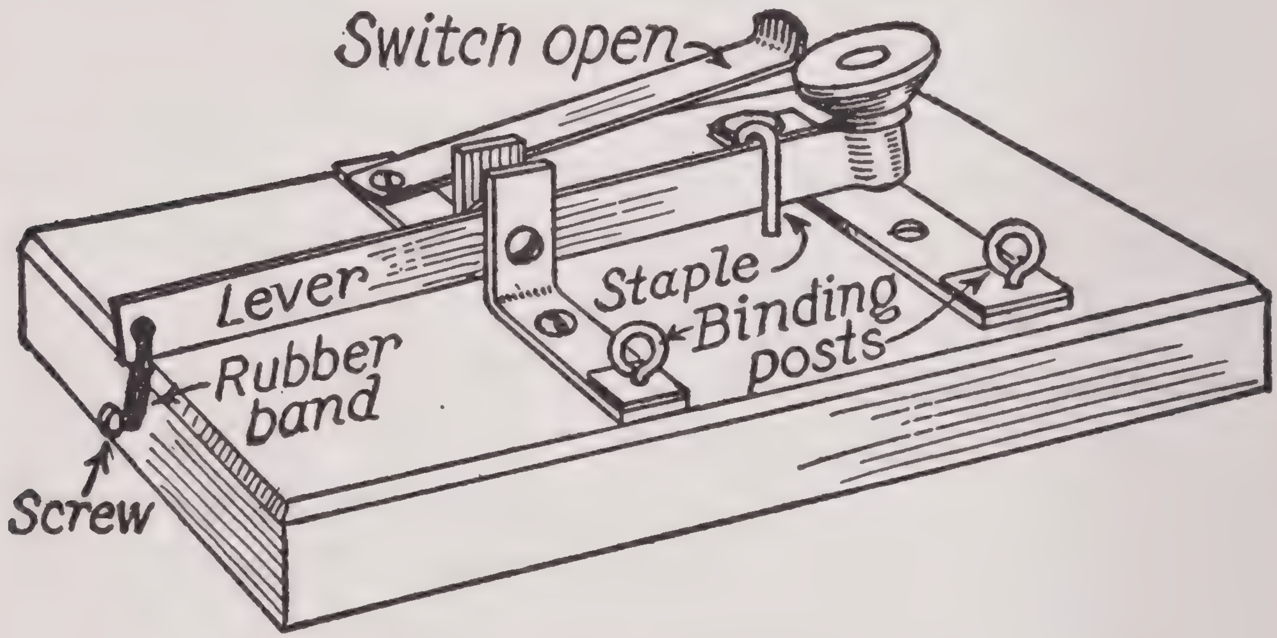



FIG. 299. — A Home-made Telegraph Key.

Probably the best outfit to begin with is

**A Telegraph.** Rig it up between your home lab and your chum's house. There is not much to the outfit —a *battery* for current, a *wire*, a *key* for regulating the flow of current in the form of dot and dash signals, and a *sounder*, or receiver, for reproducing the signals audibly. Your chum, of course, must also have a battery, key, and sounder at his end of the line.

The home-made outfit for which working diagrams and building instructions are given upon following pages will cost little for materials. Probably you will want to substitute standard equipment later, when you have learned the rudiments of telegraphy.

Start the outfit with

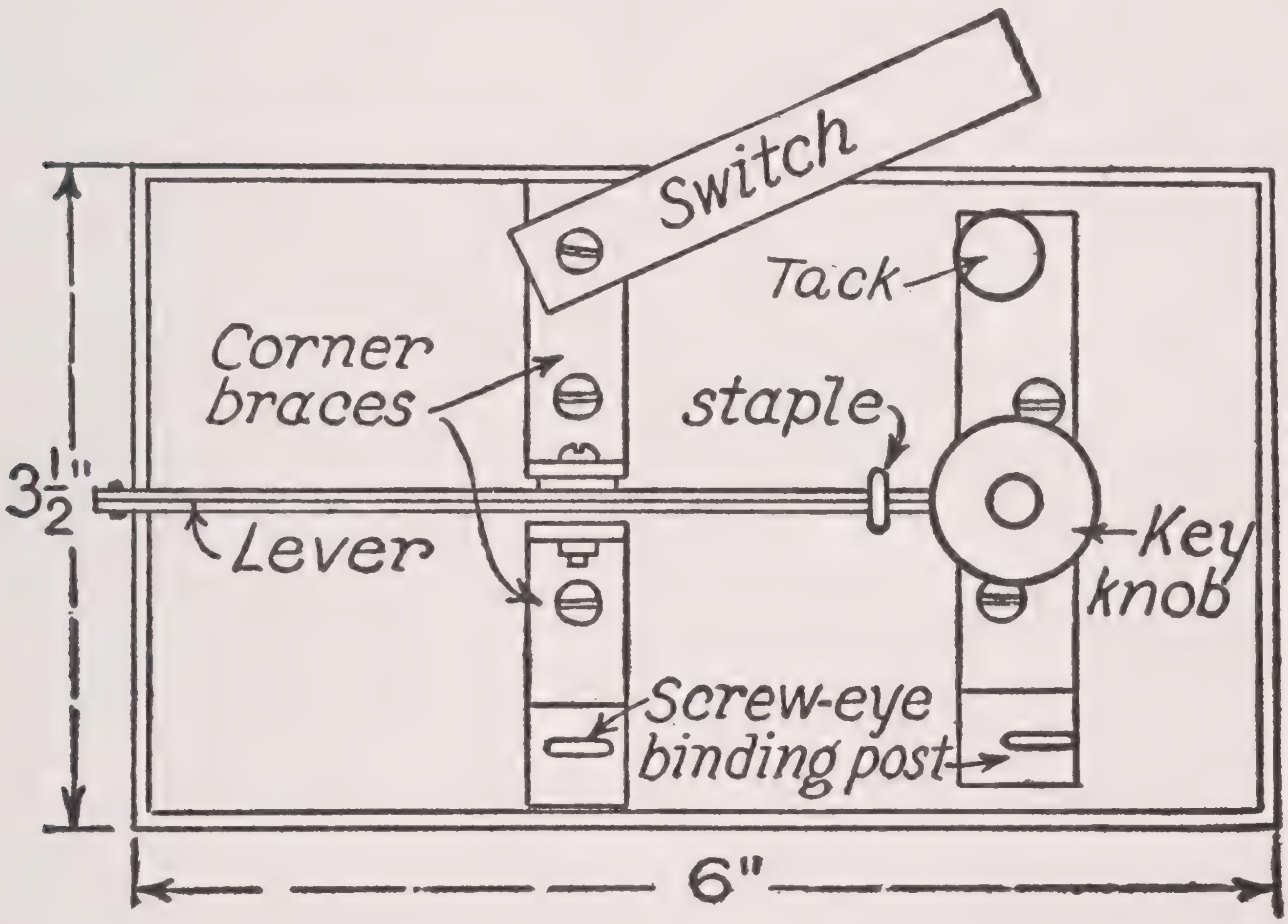



FIG. 300. — Plan of Telegraph Key.

**The Key** shown in Fig. 299. Cut a base-block of the dimensions given in Fig. 300, out of $\frac{5}{8}$-inch or $\frac{7}{8}$-inch stock. Bevel its upper edges as shown.

Make the key lever of a strip of tin of the size shown in Fig. 301, doubled along its center and then bent in half lengthwise, to give it stiffness. Make the key

knob of a spool end. Drive a short peg into its hole, and drive a round-headed tack into the lower end of the peg. Set the peg in the fold of the lever (Fig. 301) and hammer the tin tight against it (Fig. 299). Make the lever supports of a pair of $1\frac{1}{2}$ inches by $1\frac{1}{2}$ inches iron corner-braces (Fig. 301) with one leg cut off just above the second hole. Drill a $\frac{1}{8}$-inch hole through the center of the key lever, and mount the lever between the supports with a stove-bolt.

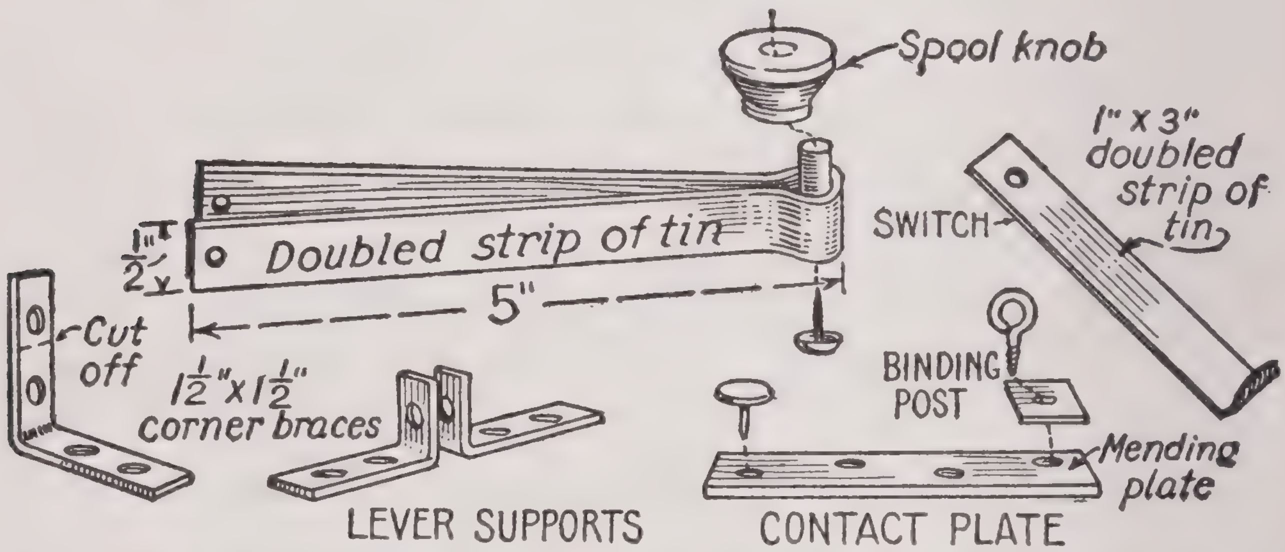



FIG. 301. — Details of Key Lever, Supports, and Connections.

Below the key fasten a mending-plate for a contact plate (Fig. 301). At one end of this make a binding-post of a square piece of tin and a screw-eye. At the other end drive a round-headed tack through the screw hole for the switch contact (Fig. 301). Make the switch of a doubled strip of tin of the given dimensions (Fig. 301) with the front end bent up. Mount it with a screw passed through it and through the end hole of a key-lever support (Fig. 299).

To assemble the key, drive a staple over the key lever just back of the knob. Drive it down so that there is about $\frac{1}{8}$ inch between it and the lever when the key is in contact with the contact plate. The rear end of the lever must have a spring to raise the key. A strong rubber band will do. Run it through a hole in the lever, and loop its ends over a screw driven into the rear end of the base block (Fig. 299).

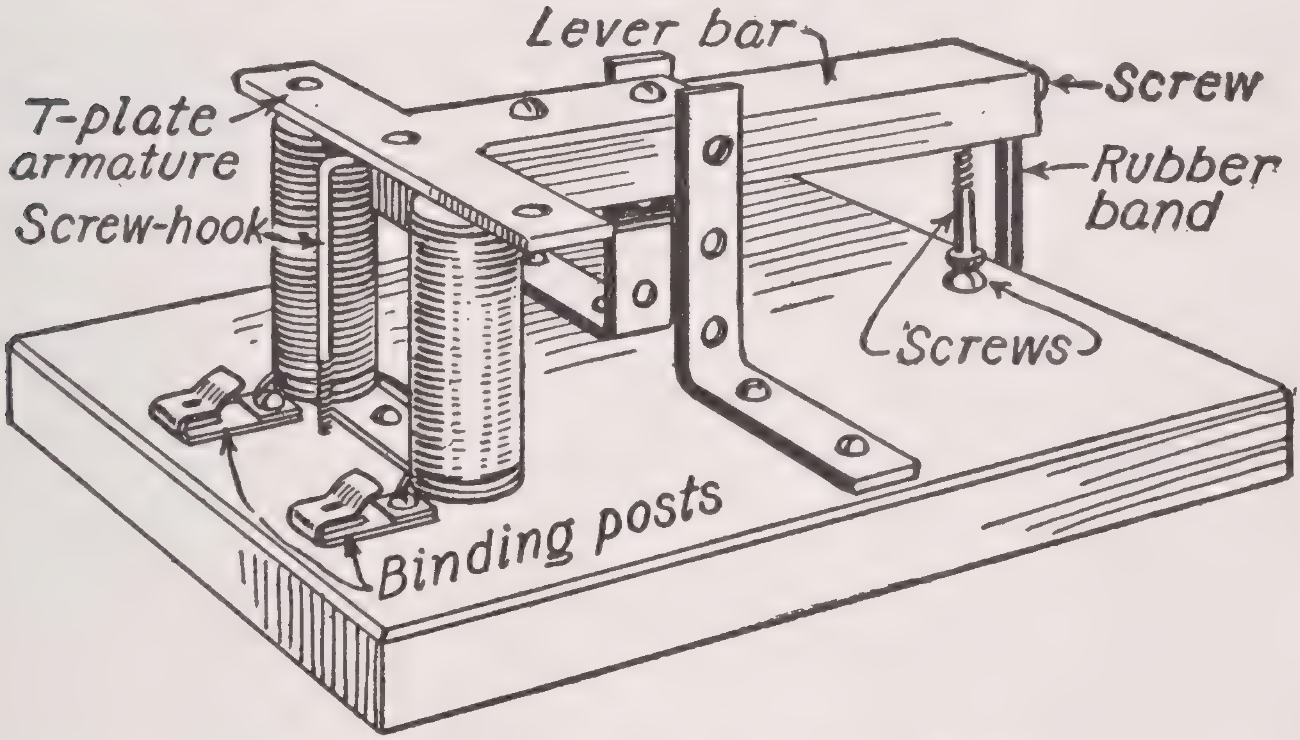



FIG. 302. — A Home-made Telegraph Sounder.

The assembled key will click when you press it down on the contact plate, and it will click again when the rubber band throws it back against the staple.

**The Sounder** is shown in Figs. 302 and 303. The first part to make is a pair of electro-magnets (Fig. 304). These require a pair of $\frac{1}{4}$-inch machine-bolts 2 inches long for cores, and insulated bell wire or magnet wire for coils. Cut six cardboard washers $\frac{3}{4}$ inch

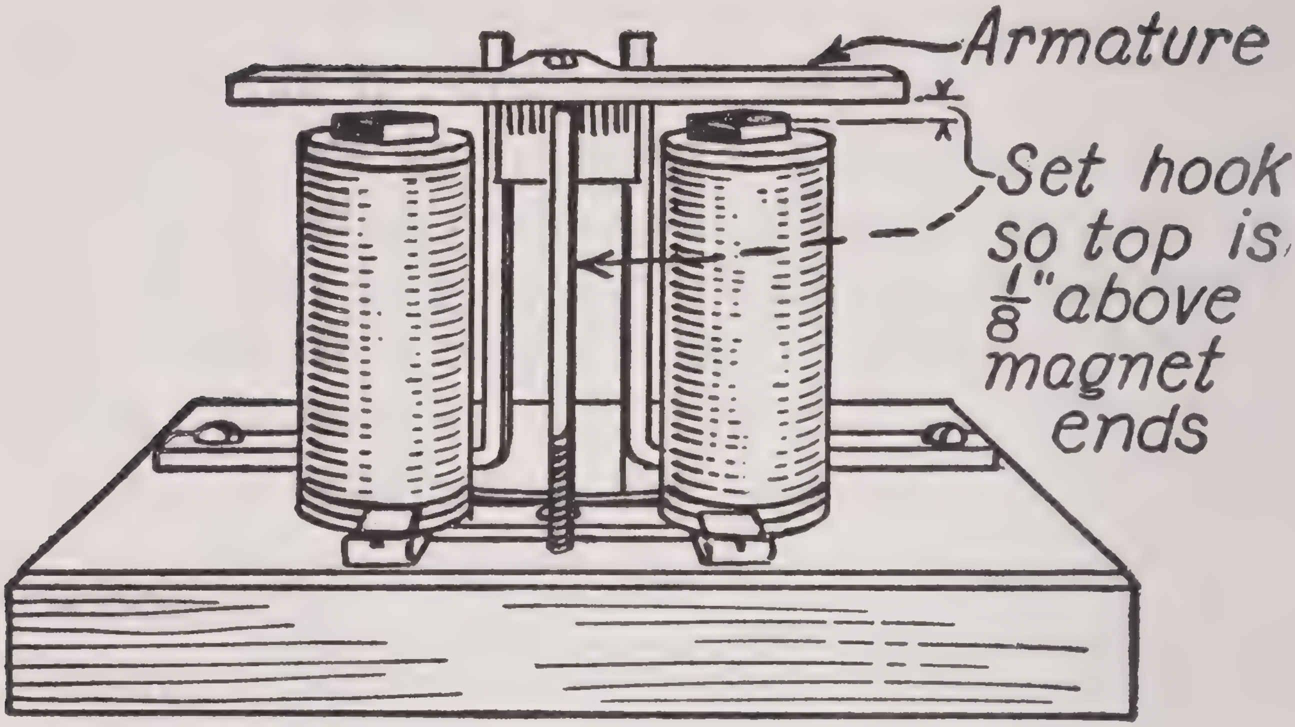



FIG. 303. — End View of Sounder.

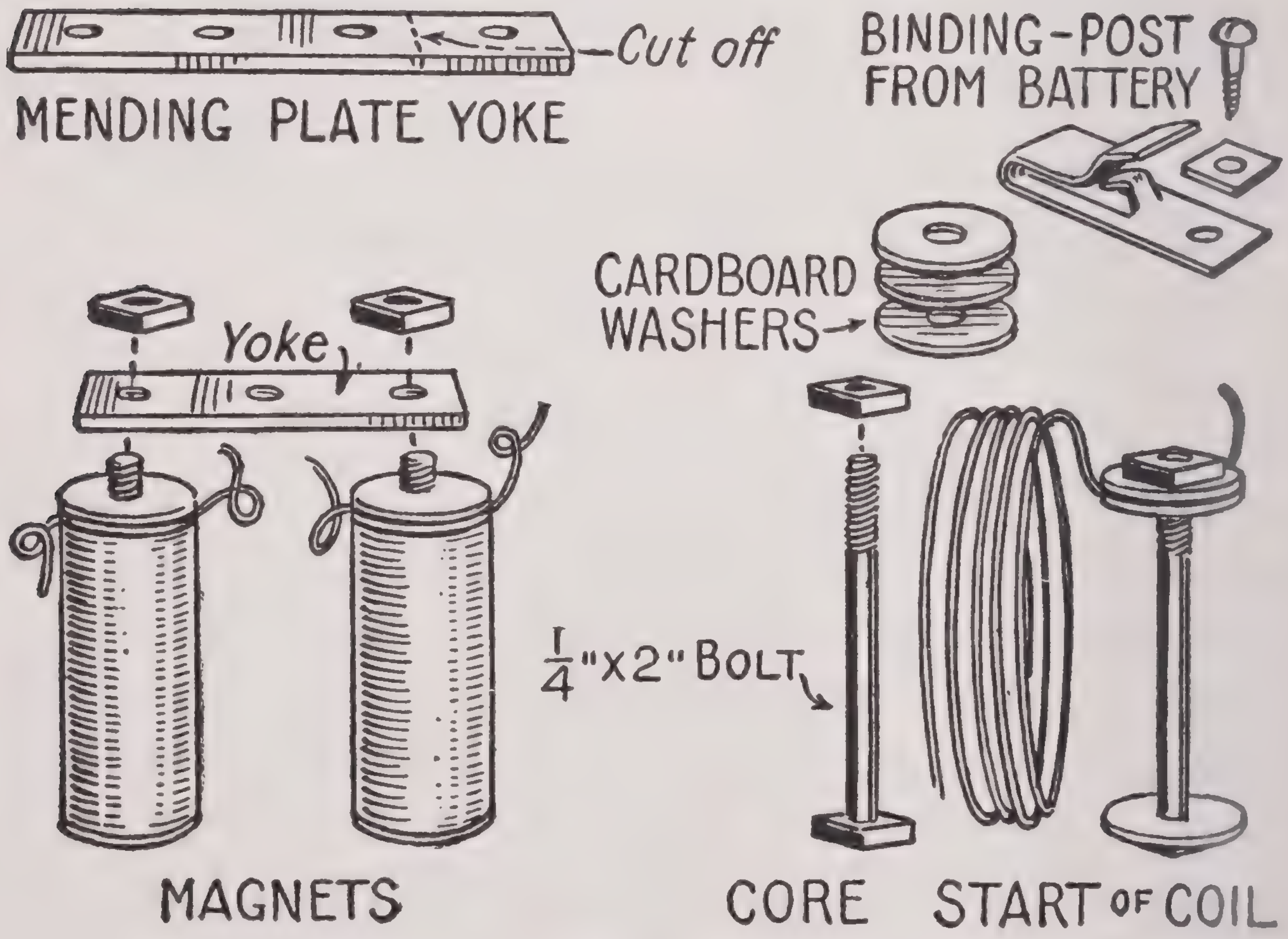



FIG. 304. — Details of Electro-Magnets.

in diameter to fit the bolts. Place three of these on each bolt, one next to the head, and two next to the nut. Wrap a piece of paraffin paper around the bolt. Then slip one end of the insulated wire through a hole in the inner washer of the pair at the nut end of the bolt, and wind the wire upon the bolt with turns close together, and one layer over another, until the coil is of the diameter of the washers. Pull out the wire end

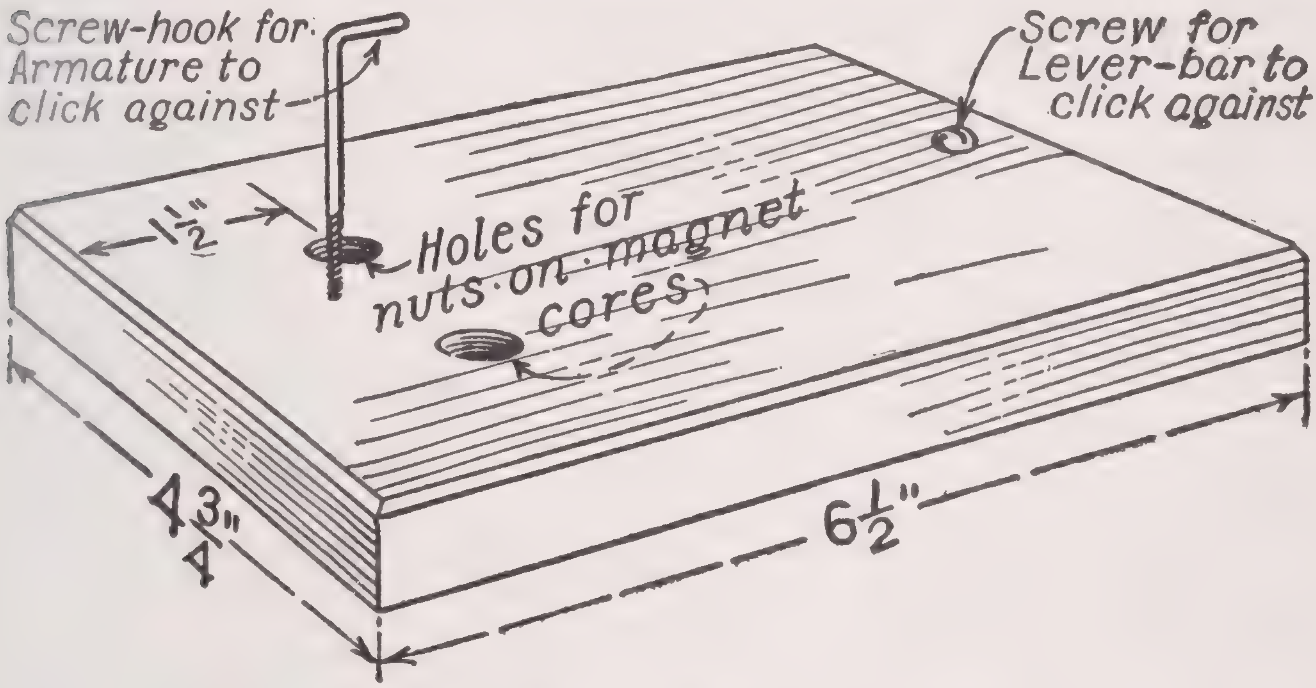



FIG. 305. — Base for Telegraph Sounder.

between the pair of washers. Make the magnet yoke of a mending-plate, with two of the holes filed large enough to admit the bolt ends, and fasten it to the electro-magnets with the bolt nuts.

Make the base of the sounder out of a block of wood $\frac{5}{8}$ inch or $\frac{7}{8}$ inch thick, and of the width and length shown in Fig. 305. Bevel its upper edges to give it a trim appearance.

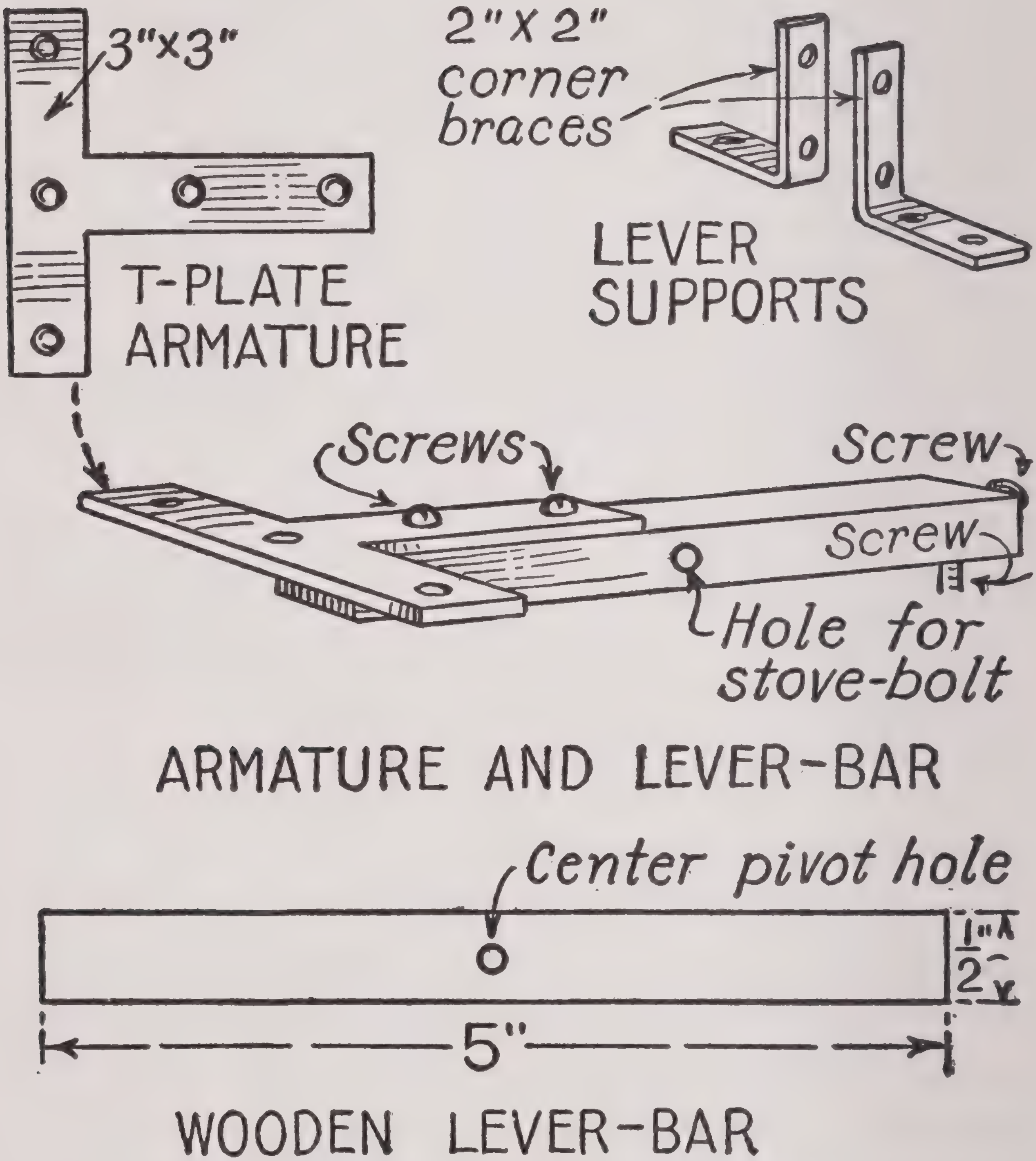



Fig. 306. — Details of Armature and Lever-bar.

**Mount the** magnets at one end of the base, bore holes for the core nuts to fit in so that the yoke will set flat against the base, and screw the yoke to the base. Remove a pair of spring binding-posts from an old dry cell and screw them to the base in front of the magnets. Then connect the inner terminal of one coil to the inner terminal of the other coil, and connect the outer terminals to the binding-posts (Fig. 302).

Figure 306 shows the armature and lever-bar. For the armature buy a 3-inch by 3-inch T-plate, and for the bar cut a strip of wood $\frac{1}{2}$ inch square and 5 inches long. Screw the T-plate to the bar end, as shown. For the lever supports, buy a pair of 2-inch by 2-inch corner braces. Drill a $\frac{3}{16}$-inch hole through the center of the edge of the lever bar, and pivot the bar between the legs of the braces with a stove-bolt 1 inch long. Place the corner braces upon the base so the armature is directly over the magnet cores, and screw them to the base.

To make the sounder click, screw a long screw-hook into the base, with its hook $\frac{1}{8}$ inch above the magnet bolt heads and turned in so that the armature will strike it. When the current flows through the magnet coils, the armature will be drawn down and it will click against the hook. The armature will be prevented from striking the magnets, which is important. If it were to come in contact, it would be held by residual magnetism. To make the click when the circuit is

opened and the armature comes to rest, drive a screw into the under side of the rear end of the lever bar, and another in the base in the right position for it to strike (Fig. 302). Regulate the lengths of these screws so that the armature will be $\frac{1}{8}$ inch above the screw-hook when the screws click. That is the correct adjustment.

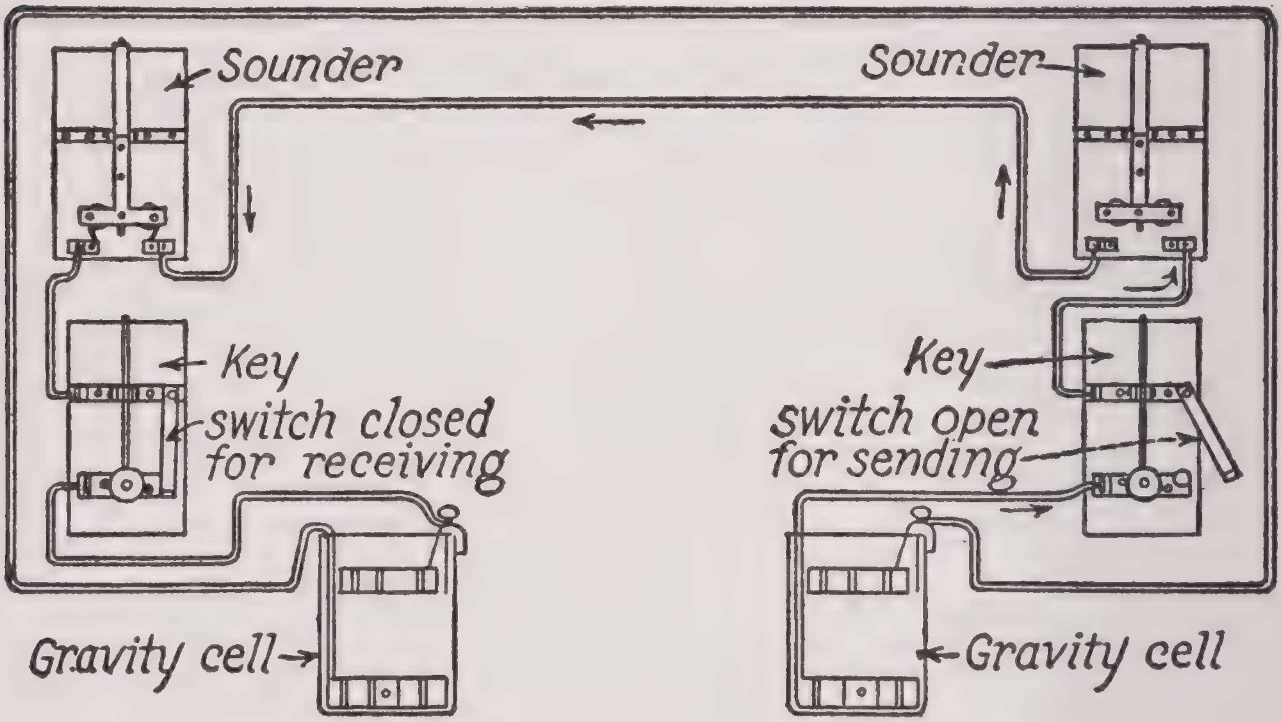



FIG. 307. — Hook-up for two Home-made Telegraph Sets, using two Line Wires.

A rubber band or spring is necessary to raise the armature. Fasten it to a pair of screws, one in the end of the lever-bar, the other in the end of the base, as shown in Fig. 302.

**The Telegraph Hook-up** is shown in Fig. 307. If your chum's house is next door, or not too far away, use insulated annunciator wire for the line. For a dis-

tance, No. 14 galvanized wire supported on insulators will be more economical.

**Operation** Notice by the hook-up diagram that the switch on the key of the set sending a telegram is open, and the switch of the set receiving is closed. As soon as you have sent a message and are ready to receive,

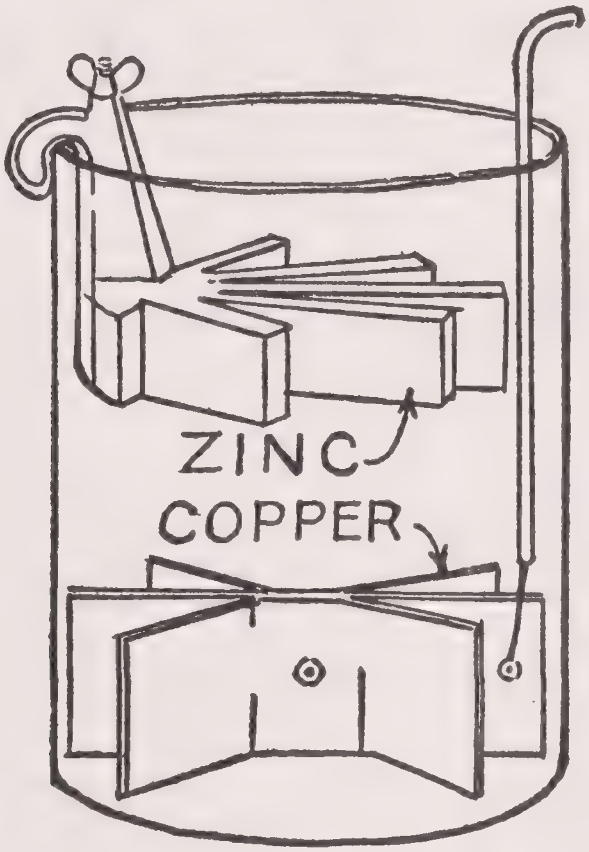



FIG. 308. — A Gravity Cell is best for a Telegraph Circuit.

close your switch. Your chum, having had his switch closed, will then open it to reply.

Both switches must be left closed when not sending. This makes necessary batteries adapted to closed-circuit work. A gravity cell (Fig. 308) is the type to use. Dry-cells will do, if you disconnect them after use. In that case, it will be necessary to telephone, or other-

MORSE CONTINENTAL

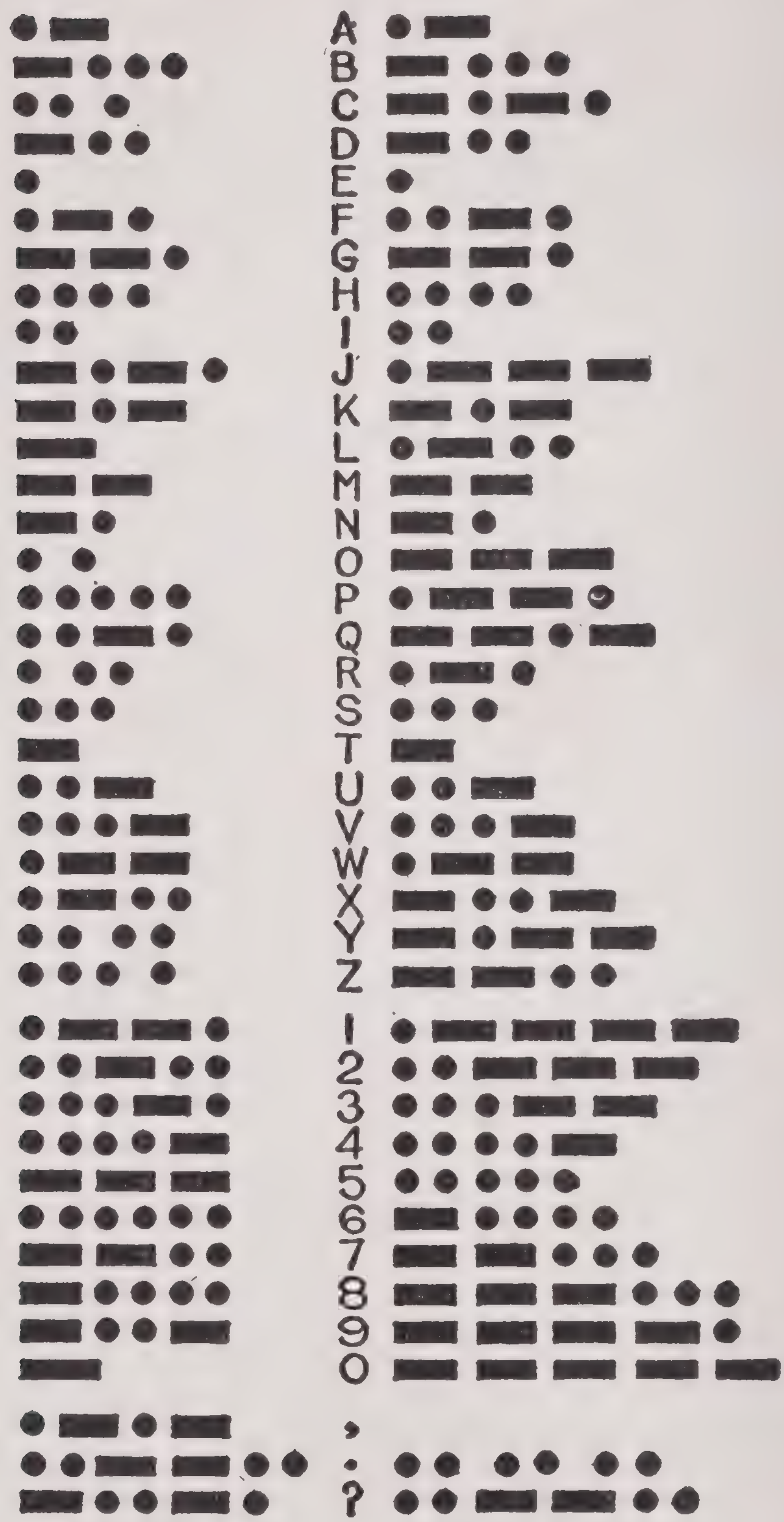



FIG. 309. — The Morse Code is used in Telegraphy. The Continental Code is used in Wireless Telegraphy.

wise notify your chum, when you are ready to use the wire, so that he may close his circuit.

**The Morse Code** is used in telegraphy, while

**The Continental Code** is usually employed in wireless telegraphy. Both are shown in the diagram of Fig. 309.

After you have acquired the knack of transmitting *dots* and *dashes* with the proper pauses, or *spaces*, between, your job will be to memorize the alphabet so that you can transmit or recognize without hesitancy the character for any letter or numeral.

In the original edition of HANDICRAFT FOR HANDY BOYS, the title of this chapter was "A Boy's Wireless Telegraph Outfit." It contained some of the first plans published for home-made receiving and transmitting sets. So successful was this outfit that thousands of amateur stations were set up all over the country. Indeed, a reader reported having used his outfit on shipboard while cruising upon the Great Lakes.

But with the advent of the World War, and curtailment by the government of amateur wireless broadcasts, the sending outfit became almost a thing of the past. Then, with developments in wireless telephony, or radio, and the introduction of radio broadcasts, wireless telegraphy was practically abandoned by amateurs for the newer hobby, and attention centered on the building of radio receiving sets. Since the price of the commercial set was then beyond the reach of the

average person, the home-made set, or home assembled set of purchased parts, was in such demand that amateur builders could not turn them out quickly enough to supply relatives, friends and neighbors. The author remembers well the thrill he obtained with his first one-tube set. Having completed it late one New Year's eve, he put on the head-set, turned the dial, and almost instantly he was listening to the chimes of

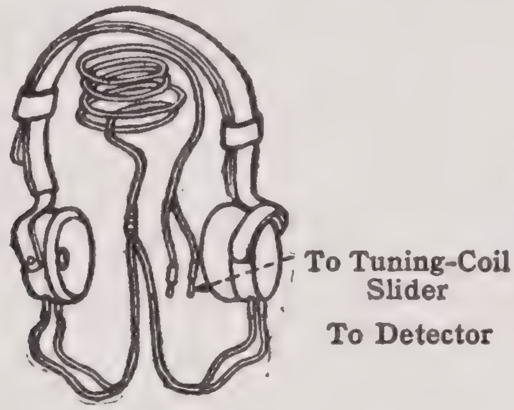



FIG. 310. — A Good Pair of Telephone Receivers with Head-band and Cord.

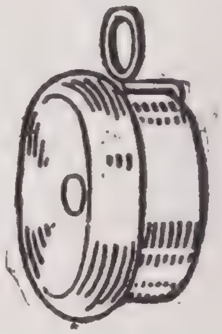


FIG. 311.— A Single Receiver.

Trinity Church, New York City, some thousand miles distant.

In the early days of radio, broadcasting stations were few and far between, and there was little interference. Tuning in a station was simple. The crystal wireless receiving set became the beginner's first radio set. And for receiving broadcasts from stations not over 20 miles distant, crystal sets are still effective. Plans for the crystal receiving set originally published in this chapter have therefore been retained.

**A Crystal Receiving Set** requires a single *receiver* or a pair of them, a *detector*, a *tuning-coil*, a *condenser*, and an *aerial.*

**The Receivers** are part of the set that you cannot build satisfactorily. (Figs. 310 and 311.) Probably you can pick up a good pair, part of an old battery set, now reposing in some one's attic.

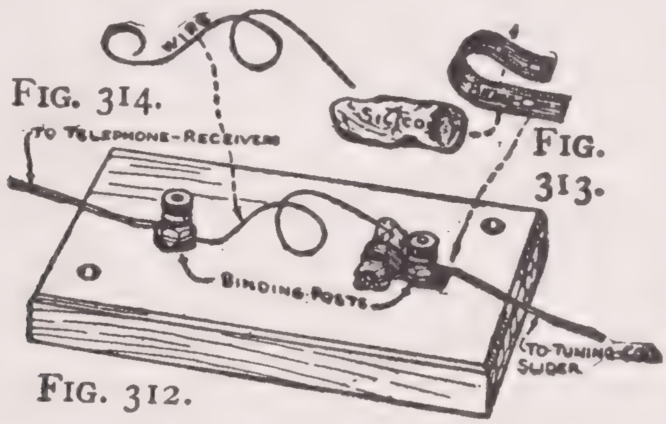



Fig. 312. — A Home-made Detector.
Fig. 313. — Strip of Brass with which Crystal is held to Binding-post.
Fig. 314. — Bend a Piece of Wire like this and connect as shown in Fig. 312.

**The Detector** is necessary to change the radio waves picked up by the aerial into such form as will be audible in the head-set. In other words, it changes the alternating current radio-frequency vibrations into direct current audio-frequency vibrations.

The detector shown in Fig. 312 requires a galena or silicon crystal, a strip of brass with which to secure it to a binding-post (Fig. 313), and a piece of No. 30 phosphor bronze wire, or springy brass wire for the *cat-whisker* (Fig. 314), or connection between the crystal

and a second binding-post. You ought to be able to obtain one of these crystals from any dealer in radio parts. Probably it will come mounted upon a small metal block, the corner of which may be fastened to the wooden base. Bend a loop in the wire cat-whisker and mount it with one end held by the binding-post, the other end resting upon the crystal. In tuning the crystal set, move the end of the cat-whisker over the surface of the crystal until the most sensitive spot is located.

**The Tuning-coil** shown in Fig. 315 makes it possible to adjust the set to the wave length of the station from which you want reception. It consists of a single layer of wire wound upon a cylinder or core not less than $2\frac{1}{2}$ inches in diameter, and 10 or 11 inches long. Use a cardboard mailing-tube or a wooden rolling-pin for the cylinder. The handles may be left on the rolling-pin to turn it by while winding on the wire, then sawed off afterwards. Use No. 25 B. and S. cotton covered magnet-wire or bare wire for the coil. If you use insulated wire, you must finally scrape bare a path for each slider so that it will make contact with the wires. If you use bare wire, you must insulate each turn from the turns adjoining it, by winding thread between the turns, as indicated in Fig. 316. Give the core two coats of shellac before winding the coil. This will form a yielding surface for the wire to cut into, and will keep the wire in place even though the wooden or card-

board cylinder shrinks after the coil has been wound. When the wire has been wound, give the surface a coat or two of shellac.

Cut two end-pieces $2\frac{3}{4}$ inches square and $\frac{3}{8}$ inch

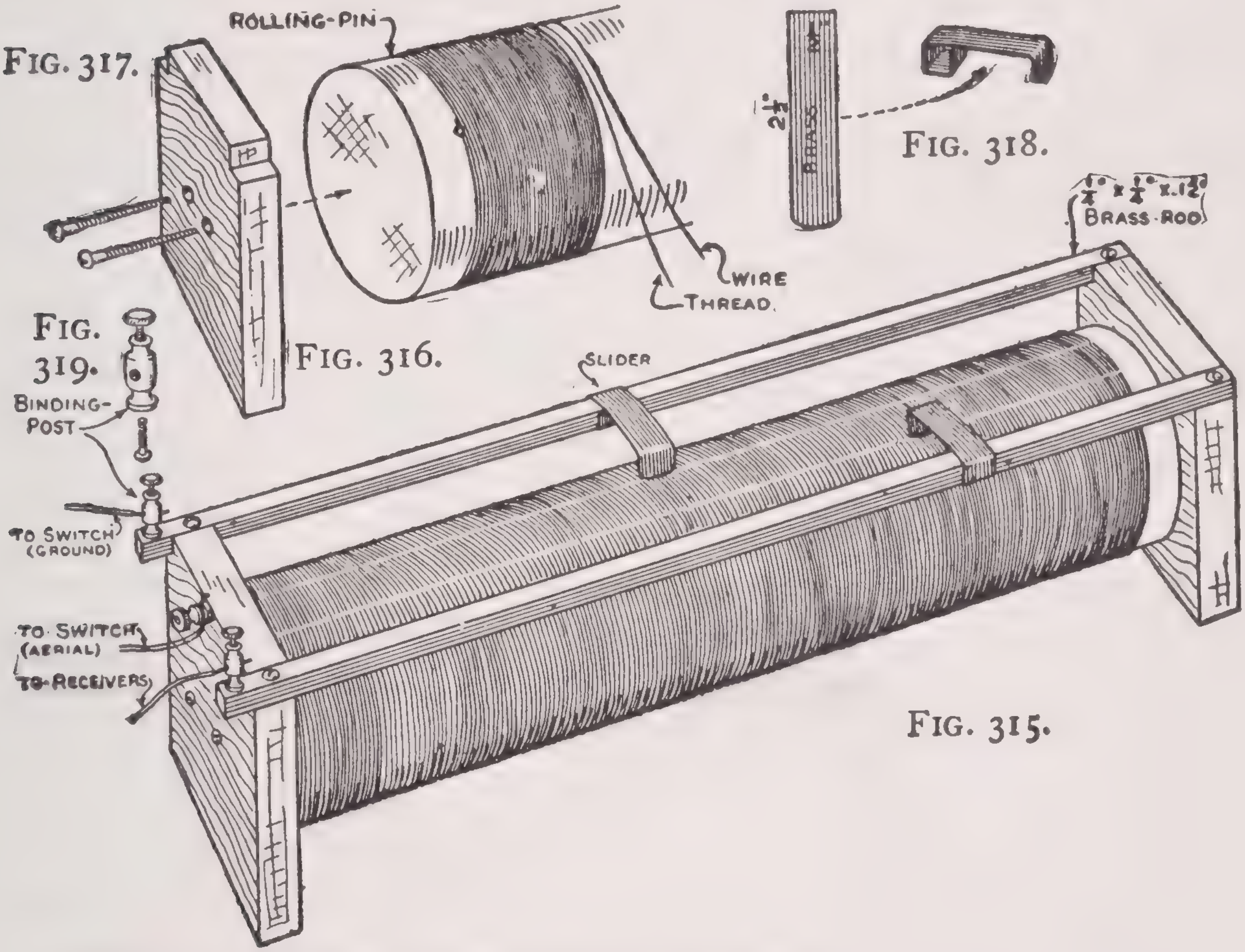



FIG. 315. — A Home-made Tuning-coil or Tuner.
FIG. 316. — How to wind Thread between the turns of Wire if Bare Wire is Used.
FIG. 317. — Prepare Two End Pieces like This.
FIG. 318. — How the Sliders should be cut and bent.
FIG. 319. — Use this Form of Binding-post.

thick, with $\frac{1}{4}$-inch notches cut in two corners (Fig. 317), and screw them to the ends of the wooden cylinder. Or, if a cardboard mailing-tube has been used, screw the end-pieces to circular blocks of the inside diameter

of the tube, and then glue the blocks inside the tube ends.

Get two pieces of brass rod $\frac{1}{4}$ inch square and 12 inches long, for the slider rods (Fig. 315), and drill two $\frac{1}{8}$-inch holes through each rod near one end and one $\frac{1}{8}$-inch hole through each rod near the other end. One of each pair of holes is provided for mounting a binding-post. The other holes are screw holes for attaching the rods to the wooden end pieces.

Make the sliders (Fig. 315) of thin, springy sheet brass. Cut two strips of the size shown in Fig. 318, and round off one end of each. Bend the square end into a square sleeve to fit over the slider rod, and bend the round end so that it will bear against the tuner and make contact with the coil. Each slider should have a slight bend in its upper face, to form a spring that will keep the rounded end in contact with the coil. When the sliders have been bent properly, slip them on the rods, and screw the rods to the end pieces with round-headed screws.

To remove the insulation from the wire along the paths of the sliders, first mark the paths by running the slider ends back and forth over the shellacked coil, then scrape through the shellac and cotton insulation with a sharp blade of a jack-knife. The folded edge of a piece of sandpaper will be helpful in removing the insulation and making the wire clean.

Having attached a binding-post to each slider rod,

fasten a third binding-post to one end-piece, as shown in Fig. 315. Connect an end of the wire winding to this third post. The tuning-coil hook-up in the set is indicated in Fig. 315.

**The Fixed Condenser** is shown in detail in Figs. 320 to 323. It is built up of sheets of tinfoil, thin writing-paper, cardboard and friction tape. Cut the cardboard and paper into the number of pieces and size shown in

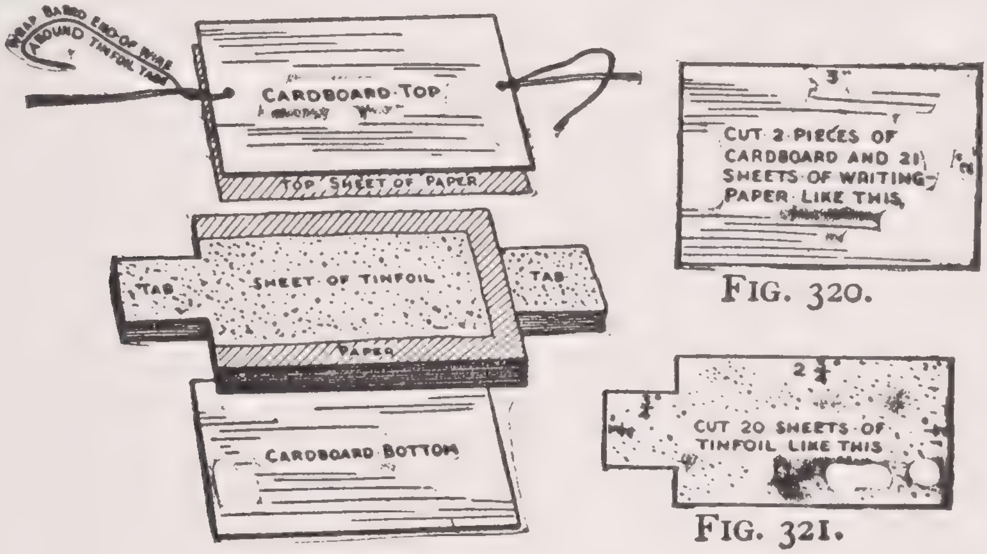



FIG. 320.

FIG. 321.

FIG. 322.

FIGS. 320–322. — Detail of a Home-made Fixed Condenser.

Fig. 320, and the tinfoil into the number of pieces, shape and size shown in Fig. 321.

Begin building the condenser by placing one of the pieces of cardboard on a flat surface. On this place a sheet of paper, then on it a sheet of tinfoil with the tab projecting at the left end. On the tinfoil place another sheet of paper, then on it a sheet of tinfoil with the tab projecting at the right end, and continue the assembly in this way, reversing the tab of alternate

layers of tinfoil (Fig. 322) until all of the sheets have been used. Over the top sheet of paper, place the second piece of cardboard. Cut two pieces of insulated wire about 12 inches long, bare one end of each, run them through the ends of the top cardboard (Fig. 322), and twist them around the tab ends of the tinfoil. By running the wires through the cardboard, before attaching them to the tinfoil tabs, whatever strain may be brought upon them will come upon the cardboard.

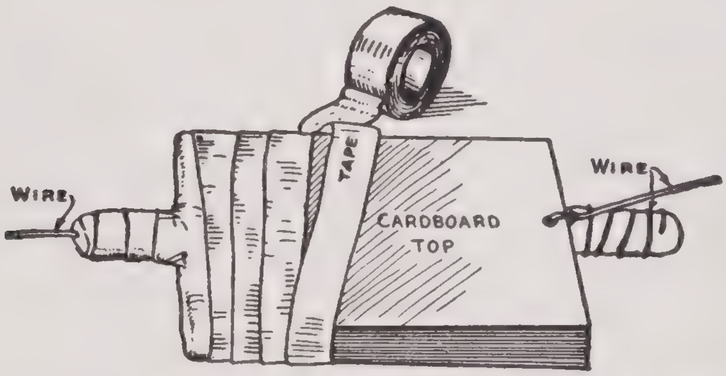



FIG. 323. — Cover the Fixed Condenser with Tape.

With the condenser assembled, wrap it from end to end with friction tape, as shown in Fig. 323. Figure 324 shows how to connect the condenser across the telephone head-set.

**Mount the Crystal Set** upon a board, using the hook-up shown in the diagram in Fig. 324. Or, if you have a desk like that in Fig. 325, arrange the parts upon it.

**Developments in Radio Sets** have been many, and they have appeared with such frequency that it is next to impossible to present plans for a set with any degree of certainty that it will remain in good favor very long.

Nor can one predict what parts now available will be on the market a few years hence. At the date of this writing, amateur builders are fortunate in being able to obtain old-model sets for little or nothing, from which much can be adapted to build late types of sets. Short-wave sets are now the fad, transmitters as well as receivers, while the more ambitious fans are tinkering with television. All that is new in radio will be found in the monthly radio publications upon the news-stands, and it is recommended that you refer to them, so that you may keep abreast of the times in this interesting hobby.

Whatever your radio set may be, and whether factory-built or home-made,

**The Aerial** will be of your own rigging. Figure 326 shows an aerial or set of *antennae* of several wires. A single wire of from 50 to 75 feet in length is generally accepted as preferable to two or more shorter wires. And one length of aerial wire, extending from the extreme end of the aerial to the set, supported on insulators, is a better rig than separate aerial and lead-in, unless a perfect soldered connection can be made.

The aerial supports will be determined by local conditions. If it is necessary to extend the aerial over a roof-top, a chimney becomes the natural support for one end (Fig. 326). But where it can be done, it is better to run the aerial wire over cleared ground.

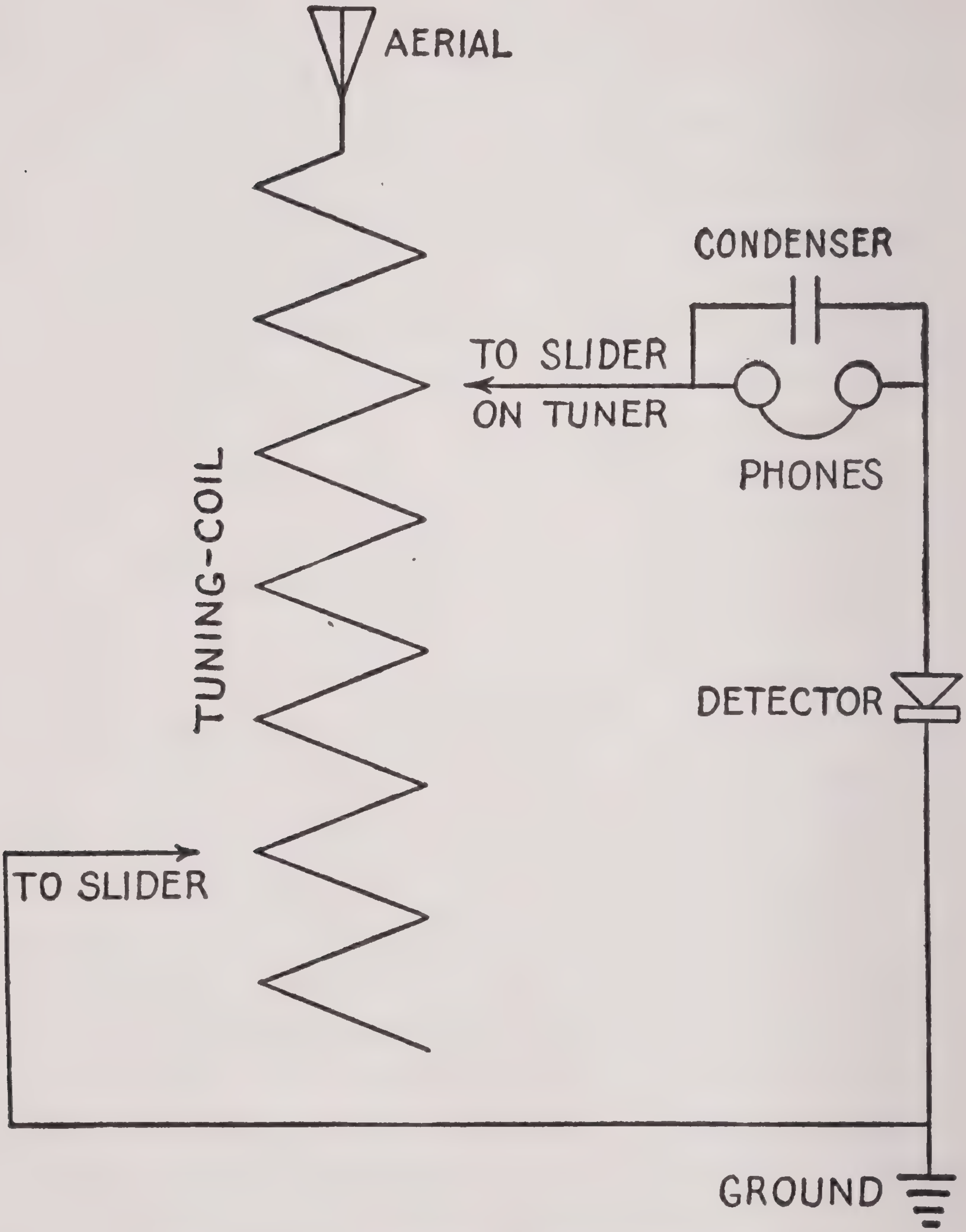



FIG. 324. — Hook-up for Crystal Receiving Set.

The receiver building may be one support, and a second building, a tree, or an iron pipe may be the other support.

**An Iron-pipe Mast** is not expensive, and not difficult to erect (Fig. 327a). You can buy galvanized-iron pipe in 20-foot lengths, threaded on both ends, with a coupler on one end (Fig. 327b), at a hardware store. Two lengths of 1-inch or $1\frac{1}{4}$-inch pipe will usually be sufficient, allowing 30 inches for ground anchorage. In addition, buy for the base, a 36-inch length of pipe of large enough diameter to slip over the lower end of the mast, a pipe cap for the top, an eye-bolt for the attachment of a clothesline pulley, a rope halyard, and an iron cleat.

**A Concrete Base** must be cast for the support of the mast. It should be about 20 inches in diameter, or 18 inches square, and 30 inches deep, of a mixture of gravel, or crushed stone, sand and cement, in the proportion of 4 parts stone, 3 parts sand, and 1 part cement.

After excavating for the base, stand the 36-inch length of pipe in the center of the hole, plumb it so that it is exactly vertical, and brace its top with temporary braces. Then mix the concrete, shovel it into the excavation, and tamp it into a compact mass. Bring the top of the concrete an inch or so above the ground level.

**Assembling the Mast.** Couple the lengths of pipe, and

FIG. 325. — Your Bedroom Lab.

screw the pipe cap to the top. Drill holes for the top eye-bolt, and for bolts for attaching the cleat, and fasten these fittings to the pipe. Unless the pipe is galvanized, give it a coat of red lead and one of black paint, or two coats of asphalt paint. With the aid of poles having end crotches formed of crossed sticks,

FIG. 326. — The Length of the Mast can be reduced by using a Chimney for Support. A Single Wire 50 to 75 Feet Long is preferable to several shorter Wires for the Aerial.

it will be a simple matter for two fellows to raise the pipe and drop it into the base pipe.

**Insulation of the Aerial** requires the use of glass or porcelain insulators (Fig. 327a). It is a good idea to use two insulators on each end of the aerial, placing them 12 inches apart. Make the lead-in wire fast to a porcelain spool or cleat, then run it through a por-

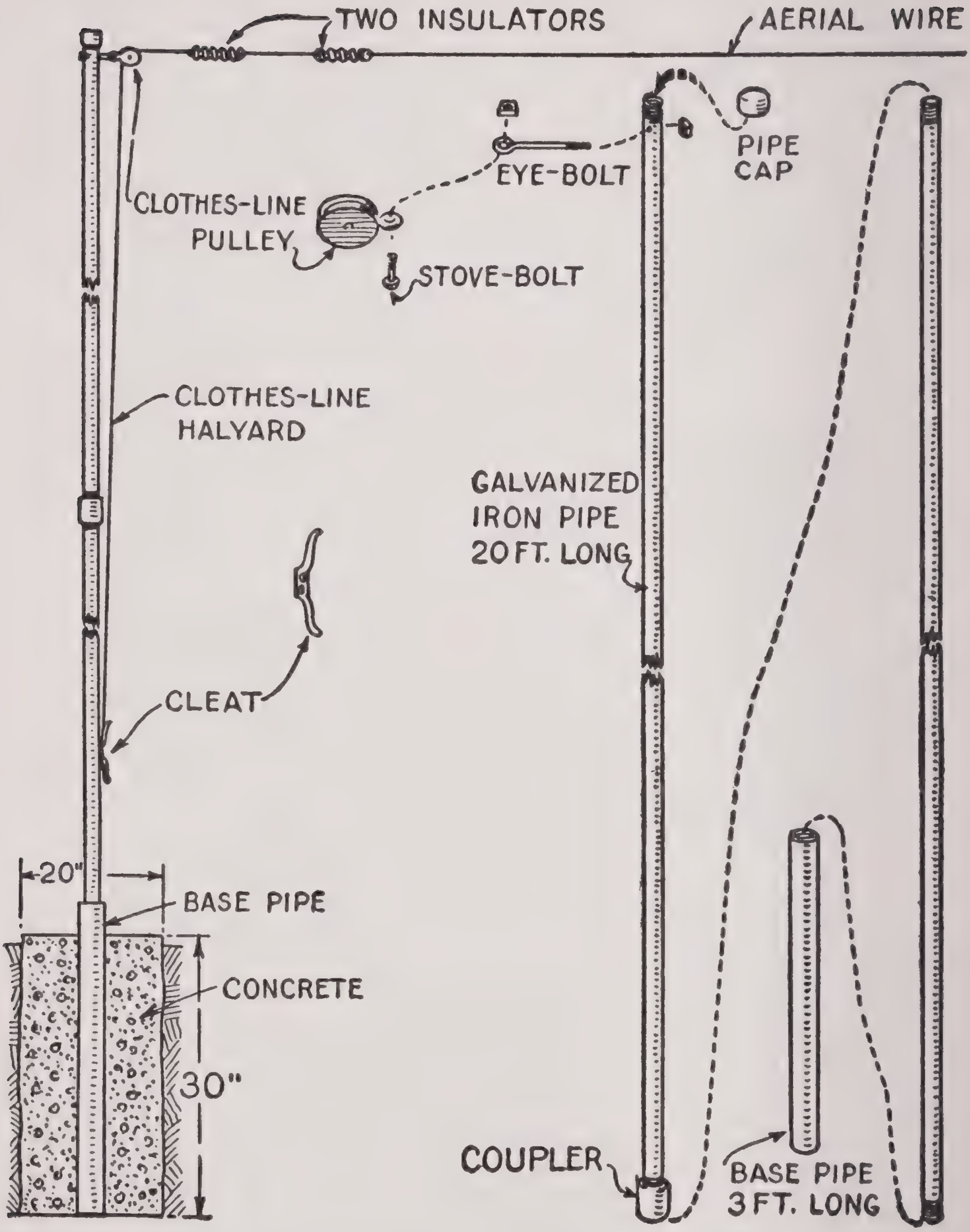



FIG. 327a. — Aerial Mast and Rigging. FIG. 327b. — Details of Pipe Mast.

celain tube set in a hole bored through the wall, window frame, or window sash (Fig. 325).

Hook up a lightning-arrester with the lead-in wire and an outside ground, to comply with rules of the fire underwriters. This will not make a ground connection, of course, unless a bolt of lightning jumps the arrester gap.

**An Electric Question-answer Map.** Electric map boards are one of the popular forms of question-answer devices, and they reveal how few people have fixed in their minds the location of the principal cities and towns of countries. Take Palestine, for example; can you chart upon an unlettered map the ten cities of Nazareth, Damascus, Tiberas, Beersheba, Joppa, Jericho, Samaria, Hebron, Bethlehem and Jerusalem? Try it. Figure 328 shows a map of Palestine adapted to a question-answer board. Each city is located by a metal contact point, and each point is connected by wire to one of a column of contact points, with a key to the city lettered opposite. Two electric wires hooked up with a flashlight battery lamp and a dry-cell determine the accuracy of positions pointed out. With one pointer placed upon the contact tack opposite the name of the city, the other pointer placed correctly on the map, the electric circuit is closed, and the little lamp lights.

**The Question-answer Board Base** may be a piece of box board, plywood or fibreboard, 12 inches square or

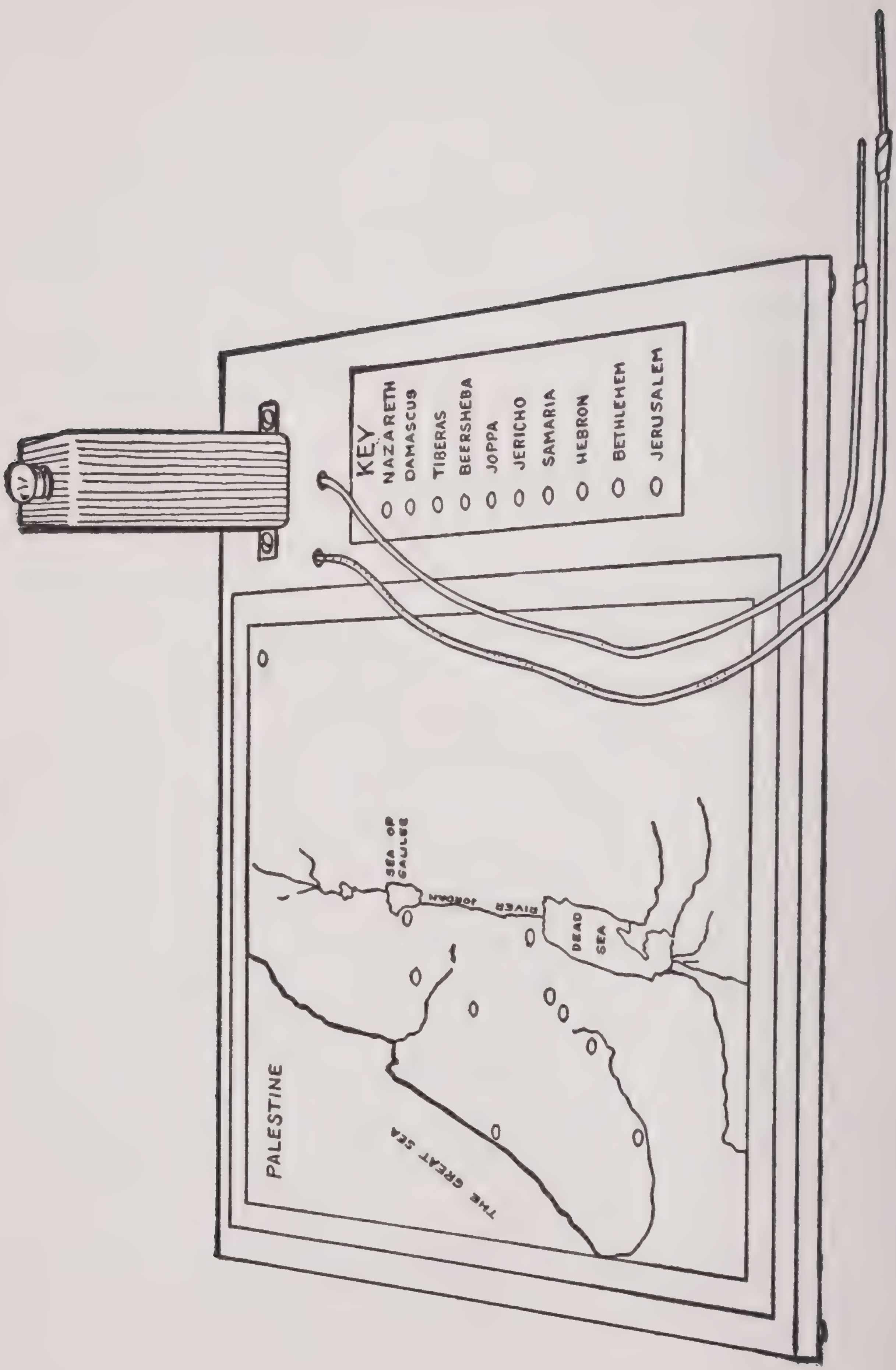



FIG. 328. — The Question-Answer Map.

thereabouts, and $\frac{3}{8}$ inch or $\frac{1}{2}$ inch thick (Fig. 329a). You will need, in addition, twenty-one $\frac{3}{8}$-inch thumb-tacks for contact points, some fine magnet wire and a piece of drop-cord, for wiring, a flashlight bulb and a flashlight unit cell, a piece of tin from a can, and a pair of $\frac{1}{2}$-inch stove-bolts.

**Make a Tracing of a Map** about 7 inches wide and 10 inches high, and reproduce the tracing upon a sheet of drawing paper. If you cannot find a map of that size, enlarge a small map by the square process. (See "Enlarging by Squares," on page 207.) Draw the map in ink and color it with crayons. Locate the cities by pricking the paper with a pin.

Place the map upon the base board, and locate the cities on the board by making holes with a pin. Locate a column of pinholes $\frac{5}{8}$ inch apart, at the right of the board, as indicated in Fig. 329b, for the key contact tacks. One-eighth inch to one side of each pinhole drill a tiny hole through the board for the wiring. Cut the magnet wire, that you obtained for the wiring, into lengths that will extend from hole to hole. Run the wire ends through the board, and form loops through which to stick thumb-tack contacts (Figs. 330a and 330b).

Coat the back of the map with glue, place it so that the pinholes center on the tacks, and press it down and weight it until the glue has set.

**Prepare the Key** on a strip of paper about $2\frac{1}{2}$ inches

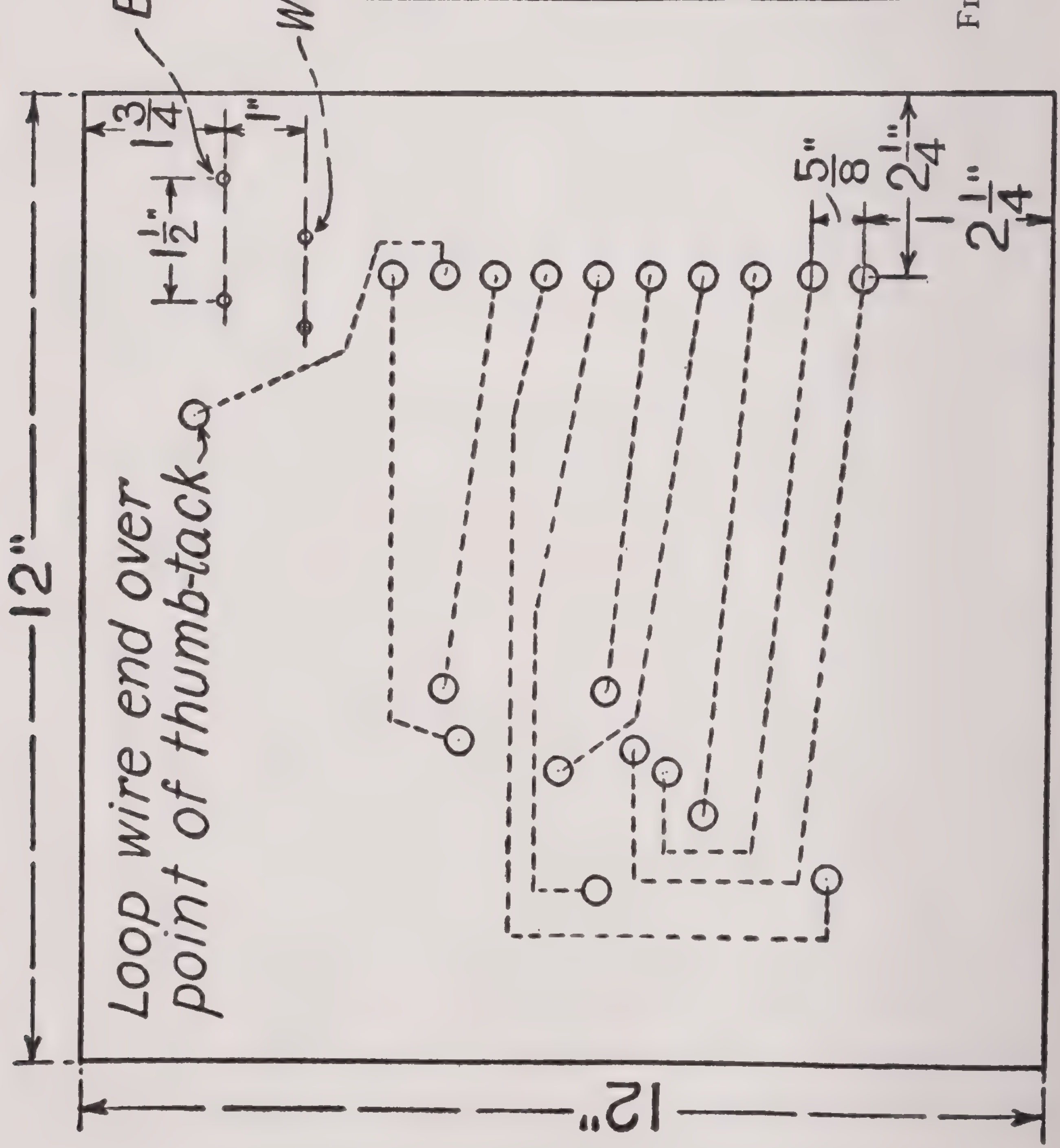



FIG. 329a. — Wiring Diagrams for the Map Board.

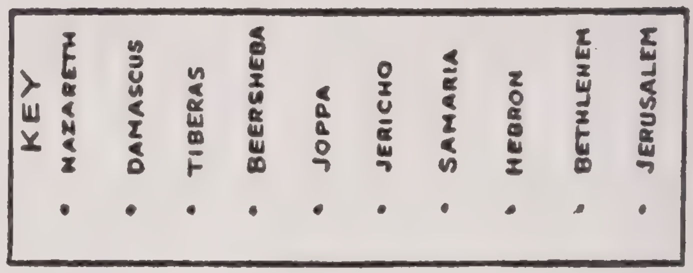



FIG. 329b. — Key Strip.

wide. Locate on this the column of pinholes, and typewrite or handletter the names of the cities opposite the holes, as suggested in Fig. 329b. Glue this strip over its tack contacts.

With the gluing done, scrape away or cut the paper at each tack, to make bared spots about $\frac{1}{8}$ inch in

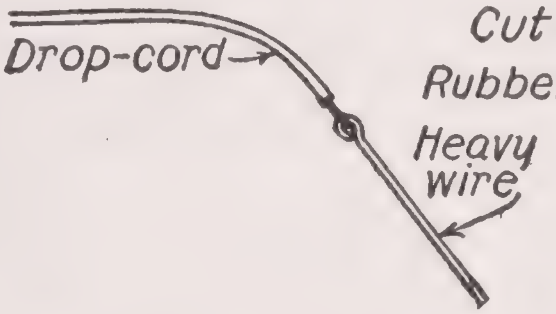



FIG. 330c.
Pointer.

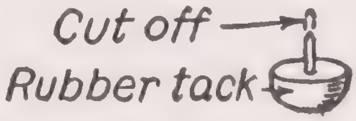



FIG. 330d.
Base Tack

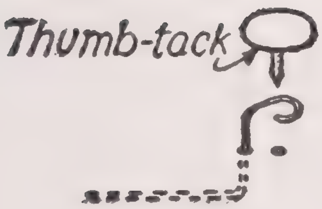



FIG. 330a.

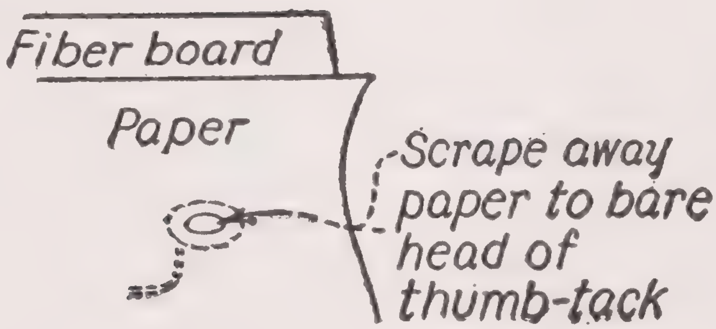



FIG. 330b.
Tack Wiring Details.

diameter (Fig. 330b). If you own a paper punch, it will make a neater job to punch the holes before gluing the paper to the board.

Figure 331a shows details of

**The Lamp Base and Battery Case.** Cut a piece of tin from a can, flatten it, and lay out upon it the pattern

shown in Fig. 331b. Cut this out, punch a hole through the top flap of the right size for a battery lamp to

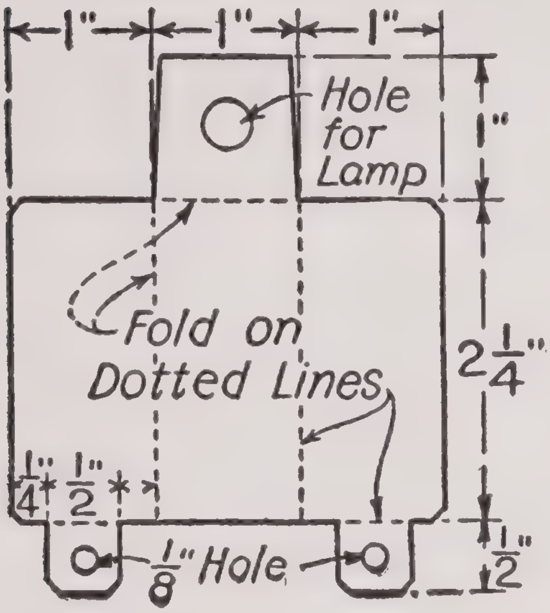



Fig. 331b. — Pattern for Base and Case.

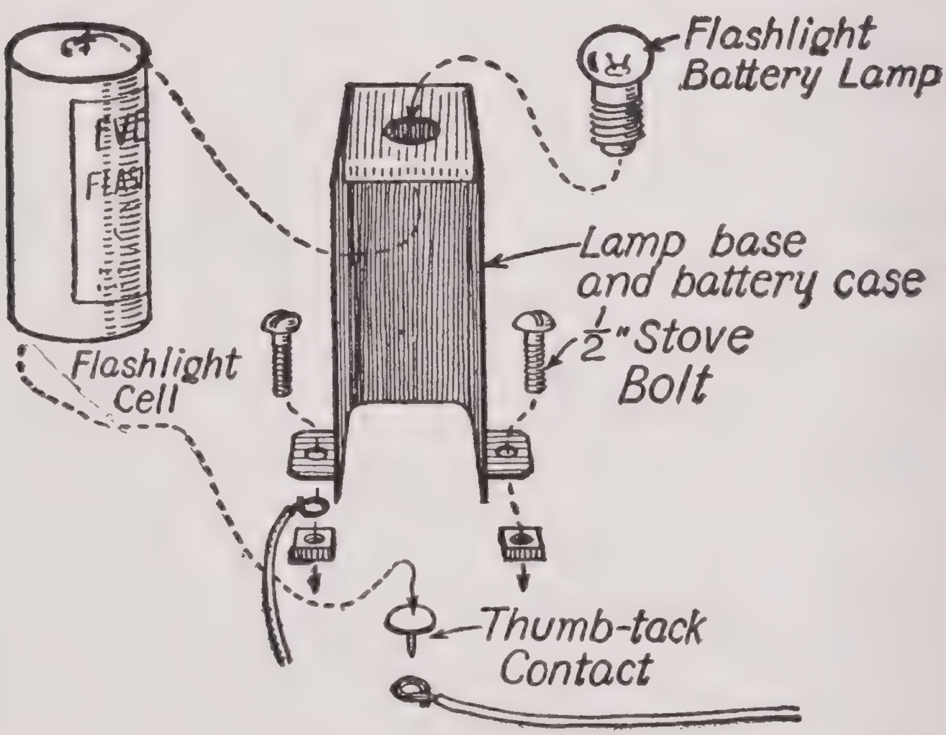



Fig. 331a. — Details of Lamp Base and Battery Case.

thread into, and punch a hole through the lower lugs for bolts. Fold the tin as indicated, and bolt it to

the base board (Figs. 328 and 329a). Cut a piece of insulated drop-cord 12 inches long, and another 16 inches long, for the lamp and battery-cell terminal-wires, and bore holes through the base board for them to run through. Then connect an end of one wire to one of the battery-case bolts, and the other to a thumb-tack contact-point at the bottom of the battery-case (Fig. 331a). Bend down the top of the case so that there will be good electrical contact when the unit cell is slipped between the lamp and the tack contact.

**For Pointers,** bend a loop in the ends of two short pieces of heavy copper wire (Fig. 330c). Connect the wires to the loops, and tape up the connections.

A rubber headed tack, glued to each corner of the under side of the base, completes the map board, unless you wish to add a coat of white shellac to all surfaces. After shellacking, clean the contact points.

**A Simple Steam Turbine.** Build good bearings into the model turbine shown in Fig. 332 and it will prove one of the best toys you ever owned. When the steam is up, the rotor begins to turn slowly, then speeds up, as the steam pressure increases, until you can no longer see spaces between the vanes. You will be thrilled with the results from this simple job, and, unless I am mistaken, you will feel the urge to build a more elaborate model, patterned after the modern turbine.

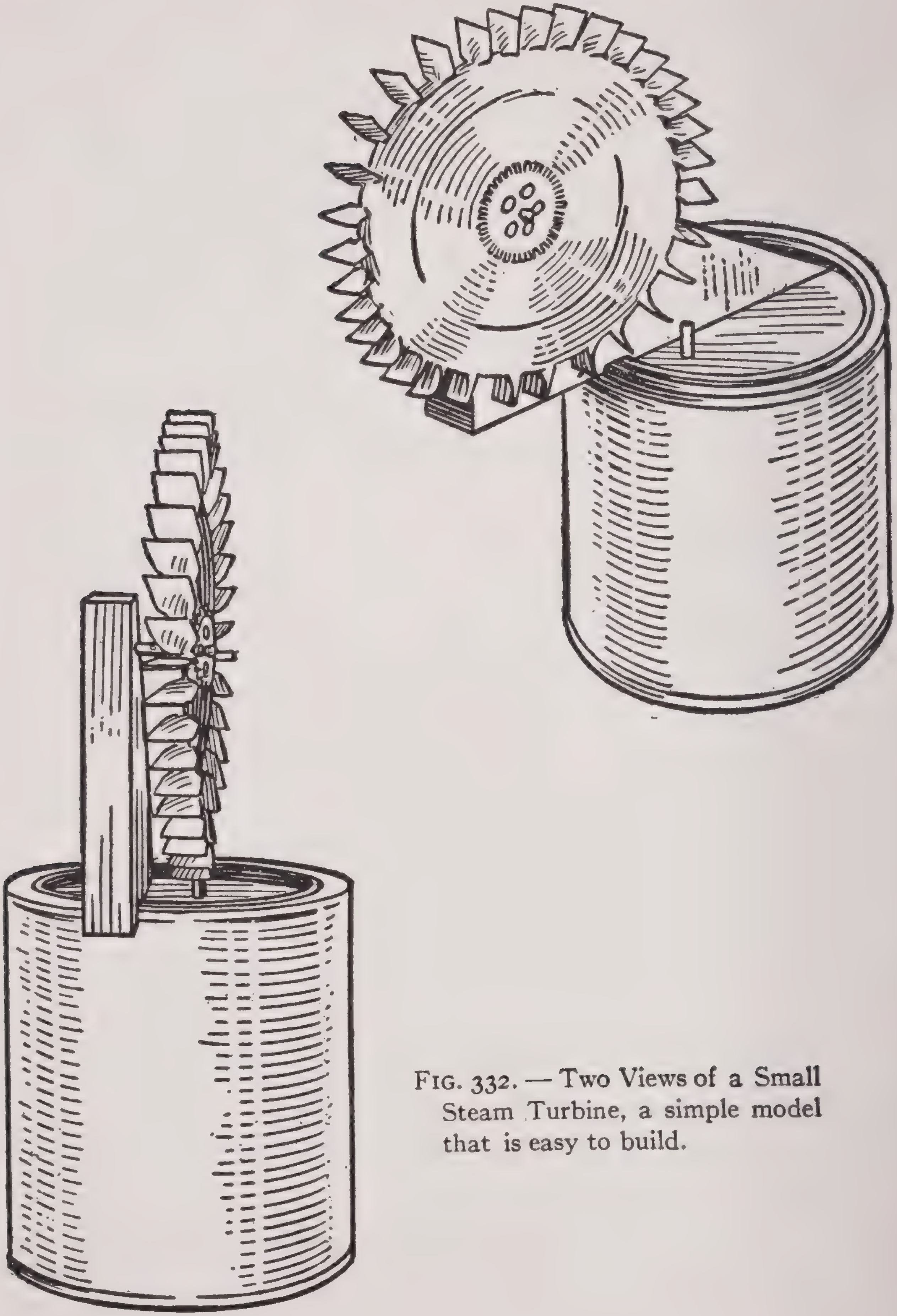


FIG. 332. — Two Views of a Small Steam Turbine, a simple model that is easy to build.

Figure 332 shows two views of the combined turbine and boiler.

**For the Boiler** get a quart tin can of the type in

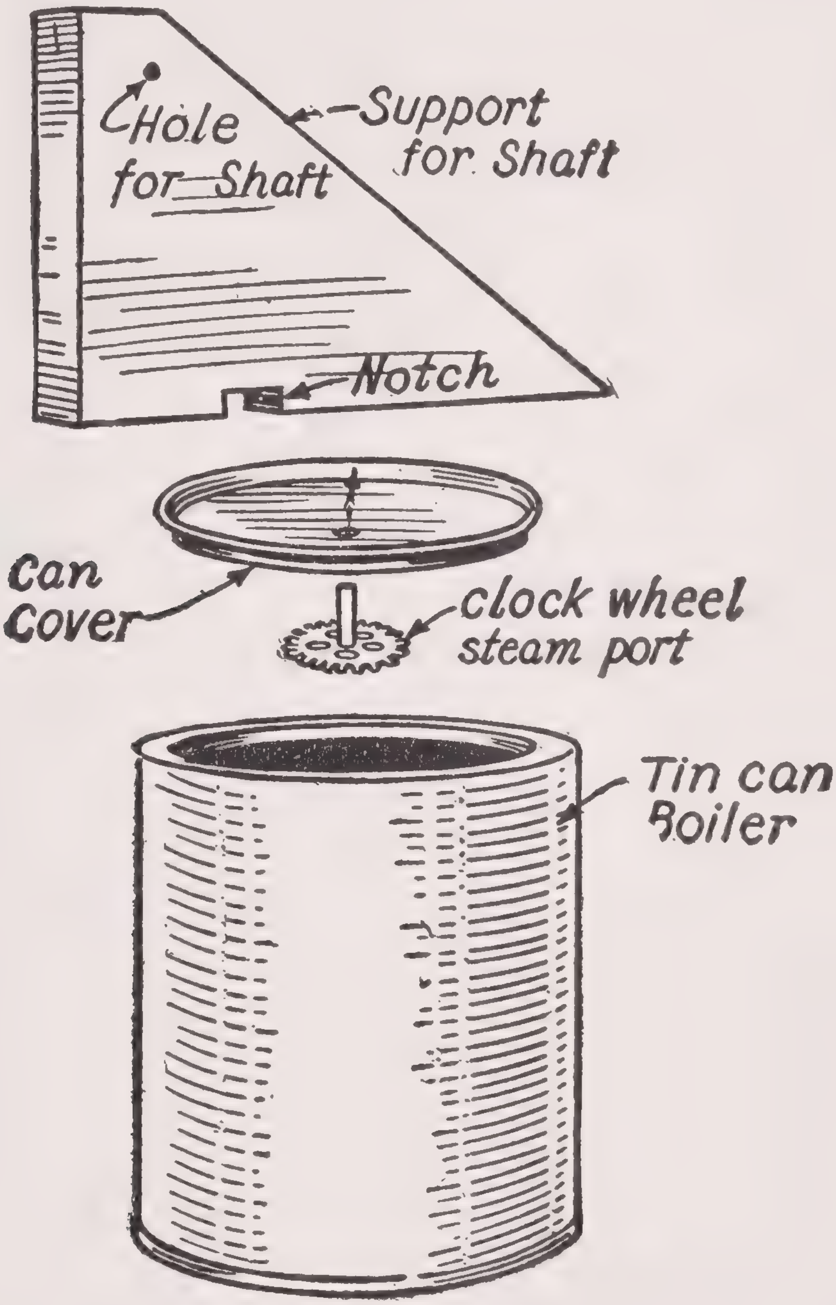



FIG. 333a. — Details of Boiler.

which molasses and syrups are sold (Fig. 333a). It will have a flanged inset cover which will make the tight fit required for the steam chamber.

**For the Steam Port,** you can solder a short length of $\frac{3}{32}$-inch brass or copper tubing in a hole drilled through the cover. But I found the small wheel with tubing hub, mounted upon the hand pivot of an old alarm clock, very good for my model (Fig. 333a). Drill or punch through the cover a hole a trifle smaller in

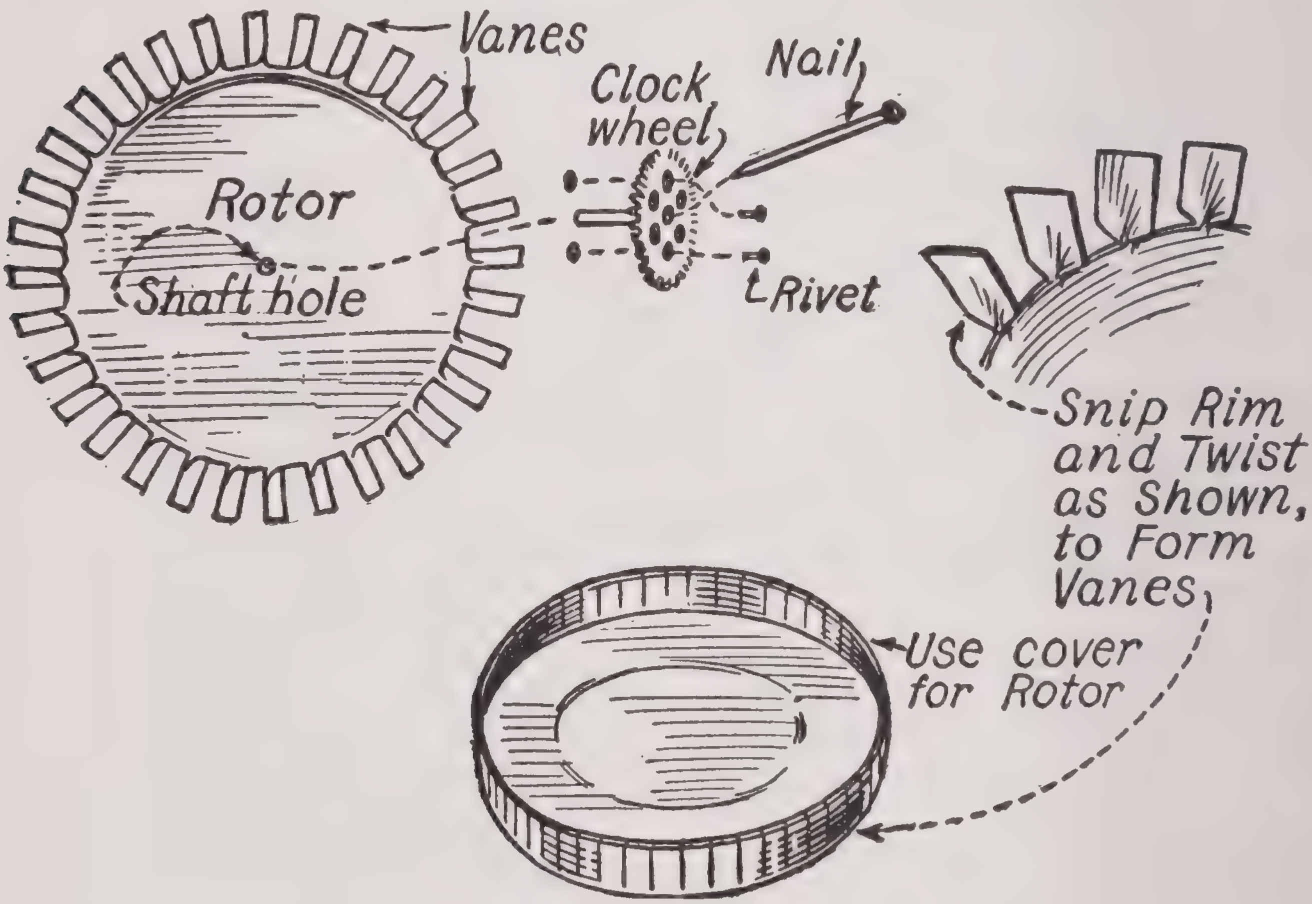



FIG. 333b. — Details of Rotor.

diameter than the wheel hub, and force the hub through the hole. This will make a mechanical joint that will not require solder.

**The Turbine Support** is shown in Fig. 333a. The lower edge is notched to fit over the flanged can top, and a hole is bored through it to admit the shaft. Its size

and the location of the shaft hole will be determined by the diameter of the rotor.

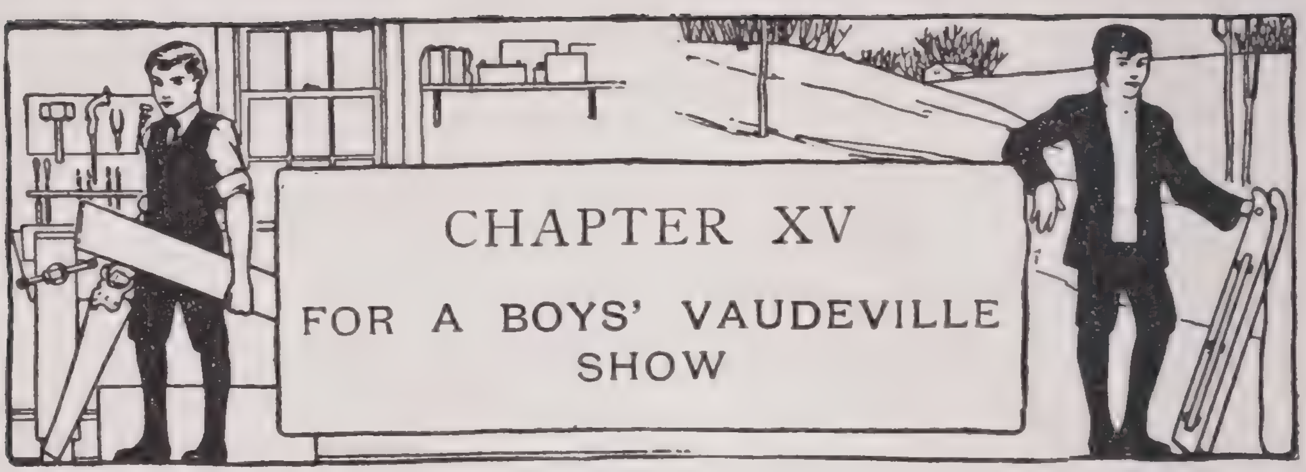
**The Rotor** is made of the cover from a coffee can $3\frac{3}{4}$ inches in diameter. A smaller size of cover will do. Snip the rim with a pair of tinsnips, as shown in Fig. 333b, at intervals of $\frac{1}{2}$ inch. Bend the tin outward with a pair of pliers, and twist until at right angles with the cover, to form the vanes. Be careful to do a uniform job of bending.

Punch or drill a hole through the center of the rotor just large enough for the shank of a clockwork wheel (Fig. 333b), and rivet the wheel to the rotor with small copper rivets. Use a finishing-nail for a shaft, and drill a small hole in the support to drive it into.

**Mount the Rotor** upon its support in the correct position for the vanes to pass over the steam port when the block is fastened to the boiler top (Fig. 332).

**Set Up the Turbine Boiler** over a gas-stove burner. When you have got up a good head of steam, you can regulate the speed of the rotor by turning the burner up or down. It is surprising how quickly the steam pressure will respond to the adjustment of the valve.

**Finishing.** After you have tried out the turbine and completed adjustments, paint the parts. Use stove enamel for the boiler, red lacquer for the rotor, and yellow for the rotor vanes and the support. Put a temporary wooden plug in the steam port to keep the lacquer from closing it, then be sure to remove it.



# CHAPTER XV

## FOR A BOYS' VAUDEVILLE SHOW

About the best kind of show for a neighborhood of boys, a boys' club, or a school organization to give is one in which each boy can do a special act or "stunt." It may be an exhibition of magic-lantern views, a sleight-of-hand performance, panorama or puppet show, boxing-match, or one of an endless variety of entertaining acts. The *strong man*, *magical mortar*, *boy with a wonderful voice*, *crack-shot*, and *ventriloquist* acts described in this chapter are easy to prepare.

**Sam Dow**, the strong man (Fig. 334), should wear a long-sleeved shirt with the shoulders and sleeves padded out to form large muscles, and should also pad the calves of his legs; if this padding throws the muscles out of their natural positions, so much the better.

For the great act of

**Holding out a Chair upon which a Boy is seated**, you will need an old seatless chair or a box with the ends knocked out and two uprights and crosspieces nailed to it for a back (Fig. 335). Drape the chair or box with a sheet or a piece of cloth of any kind large enough to

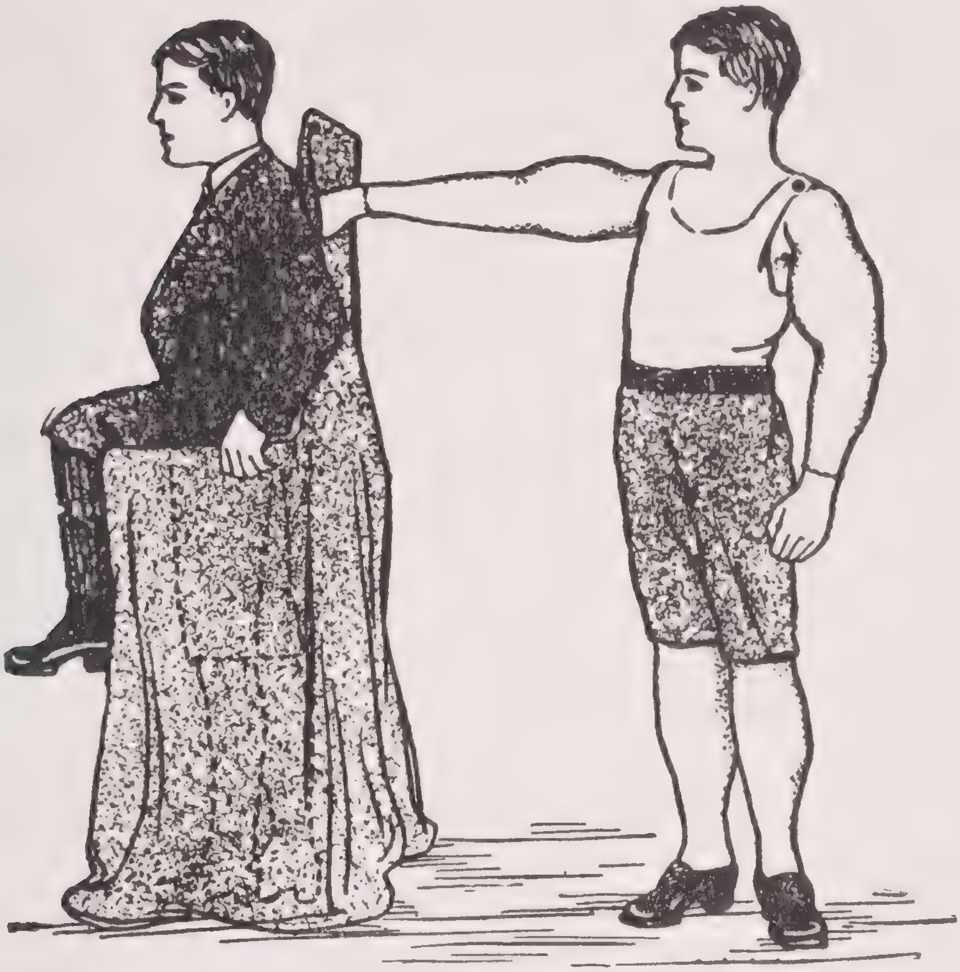


FIG. 334. — Sam Dow, "The Strong Man," holding a Seated Boy at Arm's Length.

hang down to the floor all around when the chair is held out at arm's length (Figs. 334 and 336), leaving the seat opening uncovered. Next get a pair of short trousers, stuff the legs, fasten a pair of stuffed stockings to the knees, fit the feet into a pair of shoes, and then fasten the legs to the chair, as shown in Fig. 336. The boy who is to appear to be seated upon the chair stands in the opening in the seat with the waist of the false trousers fastened and concealed under his coat (Fig. 334). While the chair stands on the floor, the boy rests on his knees, but when the strong man

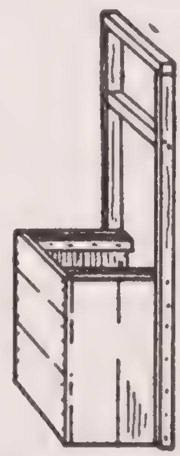


FIG. 335. Framework of Chair.

grasps the back of the chair with his hand and commences to lift, the boy slowly arises to his feet, taking the position shown by the dotted lines in Fig. 334.

Two attendants should carry the chair on to the stage, and the "seated" boy should hold on to the sides and lift his feet so as to give the boys an actual load to carry in. After Sam Dow has held the chair by each hand, and then by one finger, the audience will be convulsed with laughter if the chair is allowed to remain in the air a few seconds after he has released his hold upon it. A great deal of additional fun can always be furnished to the audience by "giving away" the trick in some such manner after a performance of this kind.

FIG. 336. — The Draped Chair with False Legs Attached.

The famous

**Dumb-bell Lifting Feat** must not be overlooked. Make the 2000-lb. dumb-bell like that shown in Fig. 337, preparing each end out of two barrel-hoops crossed at right angles with the cross-piece *A* fastened in the center (Fig. 338). Make the handle out of a piece of curtain-pole or iron pipe; if the latter is used, it can be struck by the strong man to show the audience that it

really is made of iron. Fasten the ends of the handle in holes bored through cross-pieces *A*. Cover the hoops with cloth, then on top of this place enough padding to

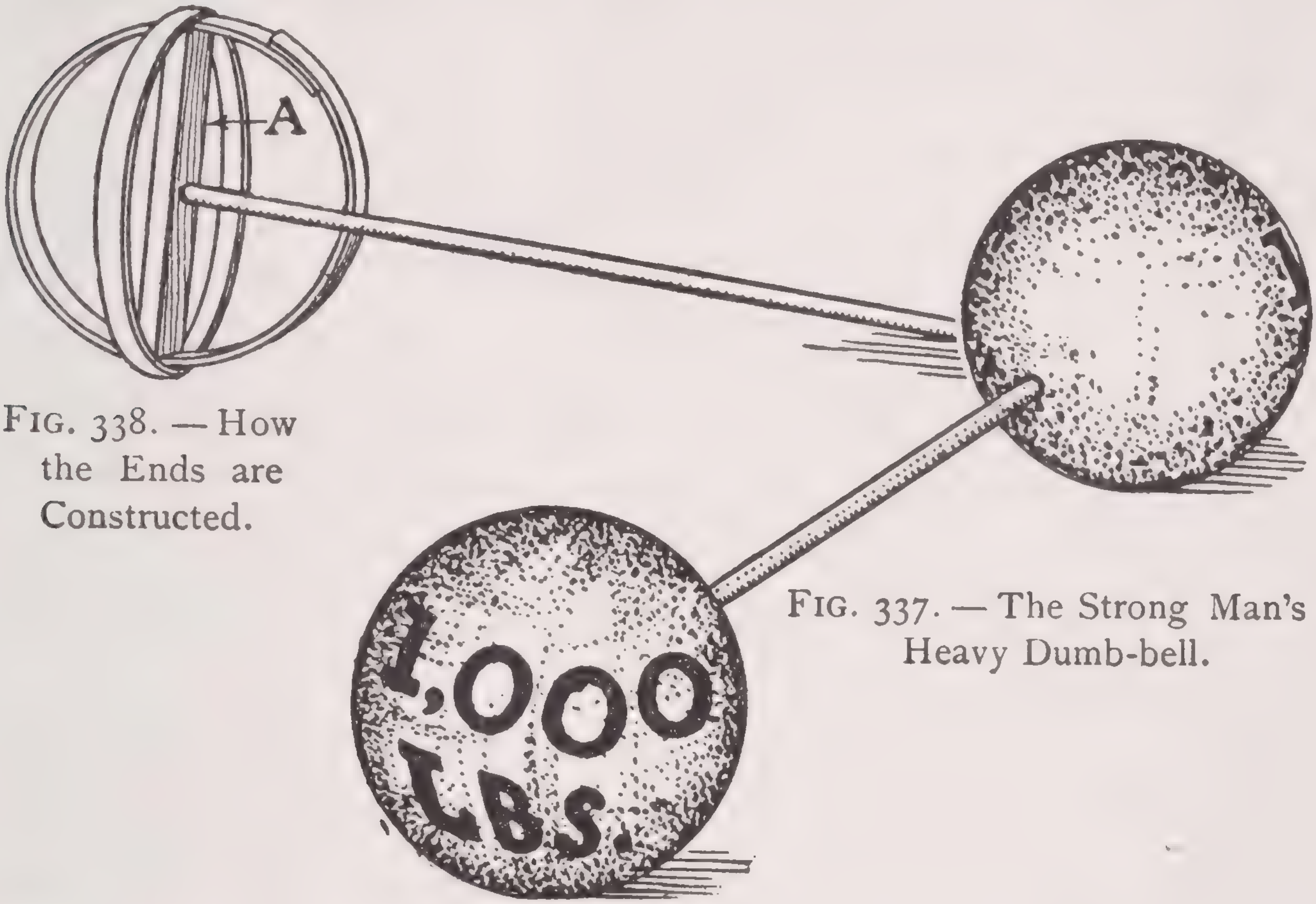



FIG. 338. — How the Ends are Constructed.

FIG. 337. — The Strong Man's Heavy Dumb-bell.

fill out the flattened portions and make them perfectly round, and cover the padding with black cloth. Paint the handle black and letter the weights upon the ends with white paint.

A couple of boys should drag the dumb-bell on to the stage, then Sam Dow should demonstrate his strength by lifting it with each hand, holding it upon his chin, balancing it on end upon his head, lying down upon his back and lifting it with his feet, and lifting it with his teeth by means of a piece of rope tied around the handle.

The strong man may demonstrate his ability as a juggler by

**Juggling with Heavy Balls** — croquet or bowling balls covered with silver or black paper, and he should introduce as a special attraction

**Bonehead**, the man with a head of solid ivory, upon which 500-lb. cannon-balls can be dropped without any apparent effect. Two balls of exactly the same size must be used in this stunt — an association foot-ball or a basket-ball for one, and a large bowling ball for the other are just the things if you can get them, otherwise use a croquet ball and a rubber ball of the same size. Cover the balls with black paper or tin-foil to make them look as nearly alike as possible.

Sam Dow should first pick up the heavy ball and allow it to crash upon the stage floor to let the audience see that it is solid; then he must pick up the rubber ball as though it were of the same weight and with an apparent effort toss it into the air so that it will land upon the head of Bonehead. Sam Dow should catch the ball as soon as it bounces off of Bonehead and toss it to one side of the stage out of view of the audience. A cracking sound should be made the instant the ball strikes Bonehead, and a louder crashing noise when Sam Dow throws it to one side. The strong man's stunts always make a big hit.

**The Magical Mortar** (Fig. 339). Get a sugar barrel from your grocer and a packing-case about 30 by 30 by

40 inches in size at a dry-goods store, out of which to construct the mortar. If the barrel has wire hoops, fasten them to the staves with small staples; if wooden hoops, fasten them to the staves with small nails. Knock out the bottom of the barrel and saw away part of one side, as shown in Fig. 340, and cut away a little of one end of the box for end *A* of the barrel to fit in (Fig. 339); set end *B* inside of the box (Fig. 339) and fasten its hoops (*D*, Fig. 340) to the box sides. Make the bearing blocks as shown at *C* (Fig. 339) and tack a piece of cloth over end *B* and to the edges of the box. Cut a 20-inch opening in one side of the box for a door (see dotted lines, Fig. 339).

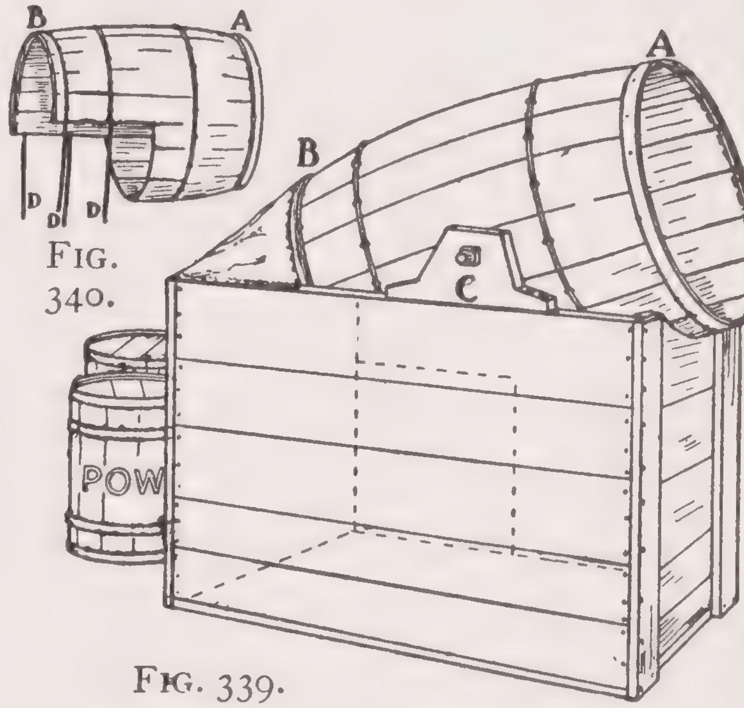



FIG. 340.

FIG. 339.

FIG. 339. — The Magical Mortar.
FIG. 340. — How the Barrel is Cut.

**The Professor** exhibiting the mortar must have two assistants, No. 1 to operate the mortar from within the box, and No. 2 to wait upon him. For

**The Wonderful Hat Trick**, the professor should take an old derby, fedora, or straw hat, a duplicate of which has been placed inside of the mortar, and in full view of the audience tear it into bits, then put the pieces

into a paper bag, throw the bag into the mortar, and shoot the hat from the mortar in a whole condition. Of course as the mortar is discharged assistant No. 1 throws out the duplicate hat, having first placed it in the bag after removing the pieces of the torn hat.

The mortar is charged from the nail keg "powder cans" standing behind it, and the report is produced by having some one strike a piece of sheet-iron with a hammer.

**Other Mortar Stunts.** The professor may place a dog in the mortar and fire out his "remains" in the form of a string of sausage, and transform all sorts of things in a similar manner.

Assistant No. 2 should wear a false-face in order to be prepared for

**The Professor's Final Exhibition.** Having run out of "gun powder," the professor sends assistant No. 2 for more, and after he has gone, moves the mortar to one side of the stage in such a position that assistant No. 1 can crawl out through the opening in the side. The professor no sooner turns around to the audience than there is the sound of a terrific explosion (strike a piece of sheet-iron with a hammer), and what appears to be the assistant's body is thrown upon the stage, with its head, arms, and legs dismembered.

The professor mourns the loss of his assistant and "powder," then thinks of the magical mortar and announces that he will put the man together again.

He gathers up the members of the body, places them in the mortar, goes out and rolls a barrel of "powder" on to the stage, and after moving the mortar back to the center of the stage, loads and discharges it. Instantly the assistant jumps forth whole and very much alive. Of course he crawls into the box, through the hole in the side, while it is over at one side of the stage.

**Make the Dummy Assistant**, thrown in at the time of the explosion, out of old clothes, ripping off the sleeves and legs of a coat and pair of trousers and stuffing each part with newspapers. Make a stuffed head, and fasten upon it a false-face similar to the one worn by the assistant so the heads will look exactly alike.

**Falsetto**, the boy with a wonderful voice, proved a great success in an amateur vaudeville. He stands in front of a curtain stretched across the stage, and back of this curtain are four assistants, — two boys, one with a bass, the other with a tenor voice, and two girls, one with an alto, the other with a soprano voice. Your sisters will probably be willing to help you out in this unseen part of the performance.

At the left of the stage the young vocalist sings the first verse of a song in *pantomime*, while the assistant with the tenor voice stands directly behind him on the other side of the curtain and does the actual singing. Responding to the applause, — which he is certain to receive, Falsetto bows, walks over nearer

the center of the stage, and goes through with the second verse in a soprano voice; for the third verse he moves a little farther over to the right, and here his voice changes to bass; and in an alto voice he sings the fourth verse at the extreme right of the stage.

With a little practice a boy will be able to get the proper expression to the mouth; and when well done you will find that this act will make one of the biggest hits of the show.

**The Ventriloquist** who throws his voice into the mouth of a doll in such a way that it sounds to the audience as though the doll were actually speaking is always a good entertainer.

FIG. 341.—The Ventriloquist operating the Speaking Doll.

It is a simple matter to make

**A Ventriloquist's Doll** (Fig. 341), and if you haven't the power of throwing your voice and talking without moving your lips, you can obtain just about as good results by having an assistant behind a curtain back

of the doll do the talking while you operate the doll's head and mouth.

Make the head framework (Fig. 342) out of 1-inch strips, and buy a false-face for the face. Cut strip *A* 4 inches long, *B* and *C* $9\frac{1}{2}$ inches long, *E* 5 inches long, and *F* 16 inches long. Fasten the end of *A* between *B* and *C*, and center *E* upon *B* and *C* (Fig. 342). Cut the false-face as shown in Fig. 343, tack the upper portion to strips *A* and *E* at 1, 2, and 3 (Figs. 342 and 343), and the chin to strip *D* at 4; pivot the end of *D* between strips *B* and *C* with a nail. With a little care in pivoting the jaw in place, the mouth will open and close to a nicety. Fasten a rubber band between *A* and *D* and a piece of string with a small ring tied to its end to the under side of *D* (Fig. 342). Set strip *F* between the lower end of *B* and *C*, and after fastening it in place whittle the lower part round as shown.

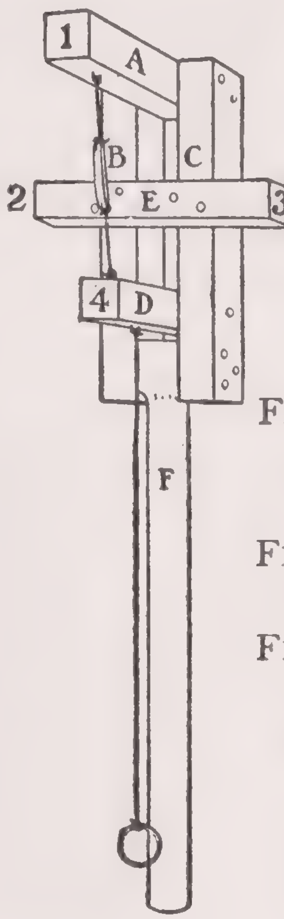



FIG. 342.

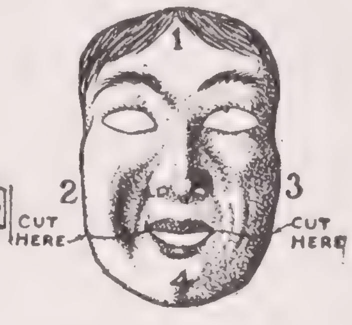



FIG. 343.

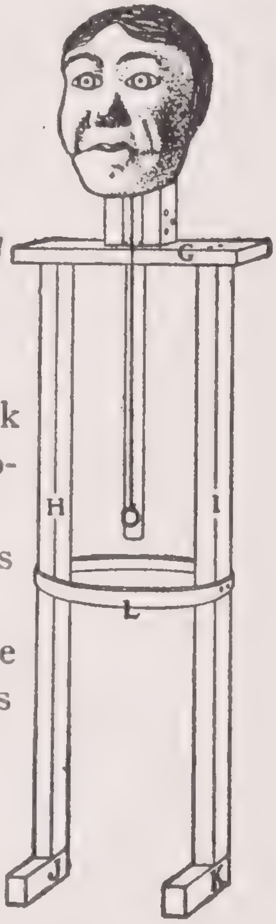



FIG. 344.

FIG. 342. — Framework for Head of Ventriloquist Doll.

FIG. 343. — The Doll's False-face.

FIG. 344. — Complete Framework of Doll's Body.

Cut the body strips *H* and *I* (Fig. 344) 30 inches in length, the foot blocks *J* and *K* 6 inches long, and the shoulder cross-piece *G* 15 inches long. Nail the pieces together as shown, and fasten a barrel-hoop to strips *H* and *I* at *L*; bore a hole in the center of *G* large enough for the neck strip *F* to turn in.

With the framework prepared it is a simple matter to put a suit of clothes upon it and stuff it out with rags and newspapers. Paste paper across the eye-openings and paint the pupils with water-colors; build out the back of the head with paper and cover it with cloth. Fasten a collar and necktie around the doll's neck and a pair of stuffed gloves in the ends of the sleeves for hands. Pin up the tails of the coat, so you can reach the end of stick *F*, and slip your finger through the cord jaw-manipulator.

Prepare a conversation to carry on with the doll, select several songs for him to sing, and request your audience to talk with him. The success of this act depends entirely upon how well the ventriloquist manipulates the head and jaws of the doll and keeps the movements in time with the talking assistant. If there is enough space behind the curtain for the assistant to walk from side to side of the stage, the ventriloquist may carry the doll about.

**Willie Shute**, the crack shot of the world, shoots portraits upon targets, an act which will interest any audience.

**The Targets** are easy to prepare. For these get some fresh pieces of heavy manila wrapping-paper at the grocery store. Sketch a simple outline of a head (Fig. 345) upon one sheet, then get a piece of small brass tubing (an old gas-burner will do) and file one end to a

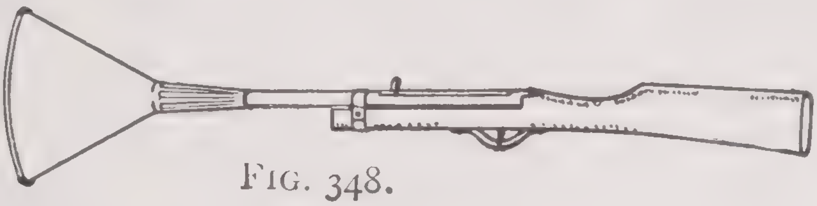


FIG. 348.


FIG. 346.

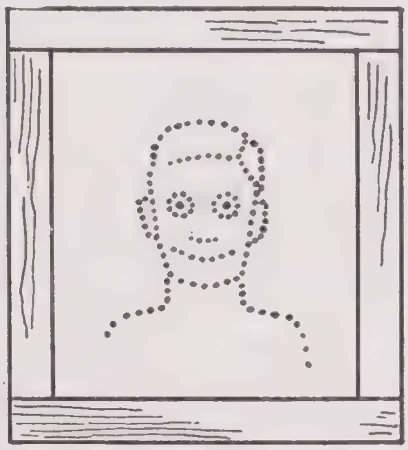


FIG. 345.

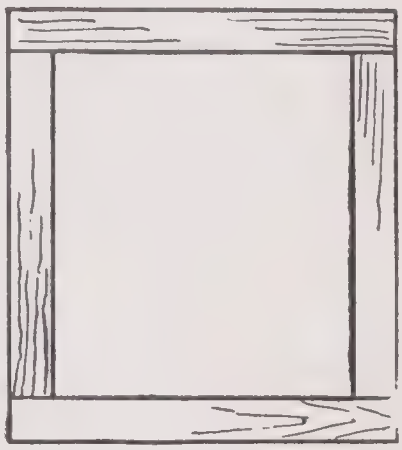


FIG. 347.

FIG. 345. — The Outline of the "Portrait" shot out by "Willie Shute."

FIG. 346. — The Reverse of the "Portrait" showing the Paper Strips over the Holes.

FIG. 347. — The Blank Paper which the Audience first sees.

FIG. 348. — Blunderbuss made for "Willie Shute."

sharp cutting edge. Lay the sheet upon a piece of linoleum, and, with the tubing as a punch and a hammer to strike it, punch out holes along the sketched outline (Fig. 345). Lay this punched sheet upon another sheet of the same kind of paper and mark the location of each hole, then cut away all except enough to cover the holes. Tack the punched sheet upon a wooden frame,

stretching the paper as tight as possible, then fasten the cut-out portion of the second sheet over the back of the holes with small paper strips (Fig. 346). Make several portraits, also write out the names of a few of the audience whom you expect, and for a final stunt have a target on which to shoot the words "Good Night!"

The frames should be set in a row upon a table and be surrounded by draperies to conceal the assistant behind them. The light should be thrown upon the targets from in front, to prevent the holes from showing as a result of shadows.

Willie Shute announces that he will shoot the portrait of a boy upon the first target, then with a small gun he aims at the target and commences to cock and pull the trigger. As fast as the trigger snaps the assistant tears off the paper backing, beginning at *A* (Fig. 346). The audience will see nothing but a blank piece of paper at first (Fig. 347), but as each hole is uncovered it will show up black (Fig. 345). With

**A Blunderbuss** made by fastening a tin funnel upon the end of a toy gun (Fig. 348) an entire portrait can be made in one shot. If you haven't a toy gun, you can whittle one out of a stick and attach some kind of trigger that will make a clicking sound.

**A Program Board** upon which to announce each act of your performance is shown in Fig. 349. Make the board 12 inches by 18 in size, and cut strips *A* and *B* 16 inches long and *C* and *D* 8 inches long. Paint the board white

and letter the word " Program " across the top with black paint. Cut the "*number*" *slips* 4 inches by 19, out of cardboard, and letter the names of the acts upon them. Hang this board at one side of the stage where an attendant can reach it easily to change the number slips.

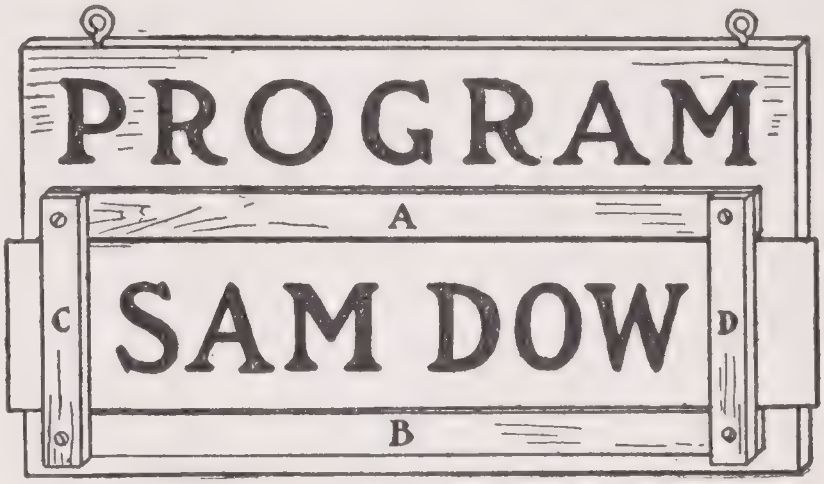


Fig. 349. — A Program Board.

Have the boy who owns a printing-press

**Print the Admission Tickets**, with the type set up in the form used for theater tickets.


# CHAPTER XVI

## MOVING PICTURES

You may have your own moving pictures at home by making

**A Simple Machine** such as shown in Fig. 350. This toy consists of a cardboard cylinder with slots cut in its sides, which is mounted upon a wooden base fastened to the end of a stick, while the pictures are made on strips of cardboard and represent a man, horse, dog, or some other subject, in action, drawn in just the positions in which it would appear in a series of photographs taken in rapid succession. The strips of pictures are placed, one at a time, inside of the cylinder close to the sides and facing in, then the cylinder is whirled around by means of the stick upon which it is pivoted, and by looking through the slots, in the sides you see a number of men, horses, dogs, or whatever the figures may be, moving just as they would appear upon the screen at a regular moving-picture show.

Fig. 350.—A Moving-picture Machine.

**The Wooden Base** for the cardboard cylinder is the first thing to make (Fig. 351). Upon a piece of board about $\frac{1}{2}$ inch thick describe a circle $5\frac{1}{8}$ inches in diameter with a compass, or if you haven't a compass, hunt up a jug or china saucer of this diameter and mark out around its rim. With a scroll-saw or a coping-saw it will be easy to follow the circle in sawing out the base, but with a large saw it will be necessary to cut off first the four corners of the board close to the circle, then the eight corners thus produced, then the sixteen corners, and so on until it is as round as you can get it, and then finish off the edge with a chisel and sandpaper.

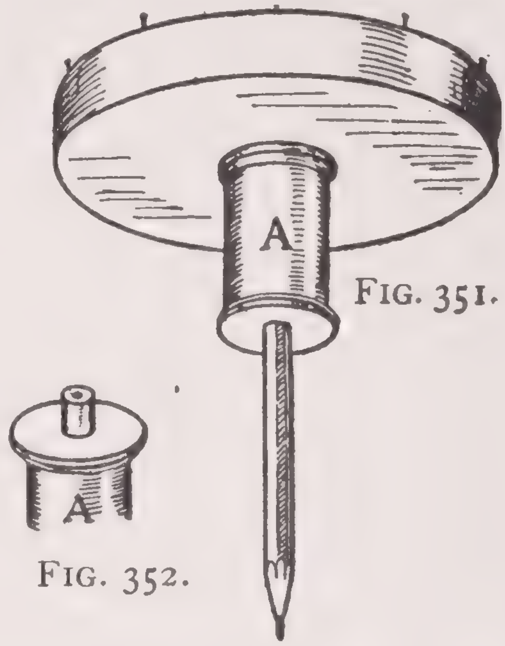



FIG. 351.

FIG. 352.

FIG. 351. — The Base for the Cardboard Cylinder.

FIG. 352. — The Spool and Pencil which are glued to the Base.

Bore a $\frac{1}{4}$-inch hole through the center of the base, then get a lead-pencil 6 inches long (or whittle a stick to the same size) and three spools, two of which will fit tight upon the pencil and the third loose. The holes in spools of different shapes vary a trifle in size, so probably you will find that mother or sister has just what you want. Push the upper end of the pencil through spool *A* so that about $\frac{1}{2}$ inch projects (Fig. 352), cover it and the top of the spool with glue, and stick it through the hole bored in the base (Fig. 351); then press spool

*A* against the base until it is glued fast. Slip spool *B* on to the pencil and glue spool *C* on to the end (Fig. 354).

**For the Cylinder** get some light-weight cardboard that will be easy to cut, mark out a piece $3\frac{1}{2}$ inches wide and

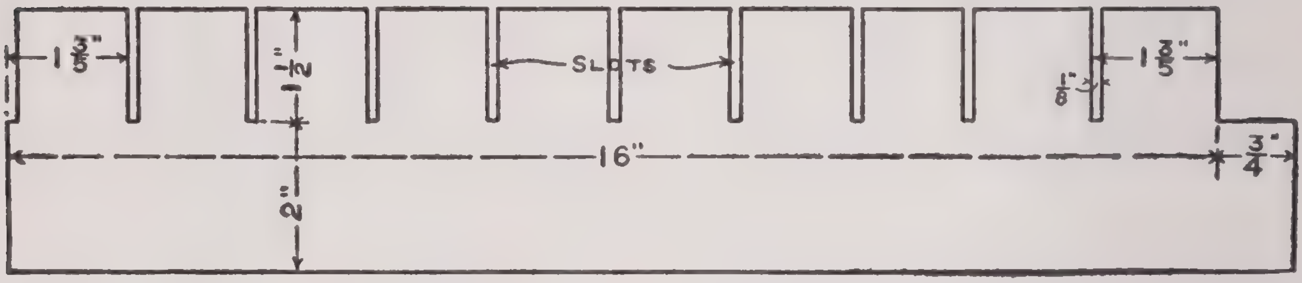



FIG. 353. — Pattern for Cardboard Cylinders.

$16\frac{3}{4}$ inches long (Fig. 353), and mark off the ten slots at equal distances apart. Cut out the cylinder with a pair of shears or a sharp knife, then tack its lower edge to the edge of the wooden base, as shown in Fig. 354, and glue the ends of the cardboard together.

**The Clown and Ball Pictures** (Fig. 355) are shown in four pieces, as are

**The Circus Horse and Hound Pictures** (Fig. 356). Each set when joined together end to end will make a strip just long enough to reach around the inside of the cylinder. They are drawn full size, so all you will have to do will be to trace them off upon a piece of transparent paper and then transfer them upon a piece of heavy paper or light-weight cardboard, plac-

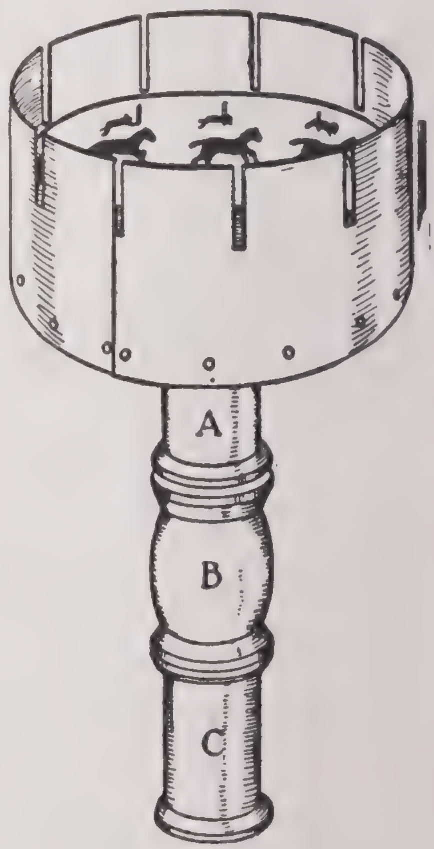



FIG. 354. — The Completed Moving-picture Machine.

ing the ends *A*, *B*, and *C* together so as to form a continuous strip. To hold the strips in place against the sides of the cylinder, drive a number of small brads into the top of the base just far enough away from the edge so the strips will slip between them and the cylinder (Fig. 351).

**To operate the Toy**, hold it by the middle spool with one hand and make the cylinder revolve by turning the bottom spool with the other hand (Fig. 350).

**The Automobile.** Figure 357 shows a modern adaptation of an old form of optical illusion. Give the book

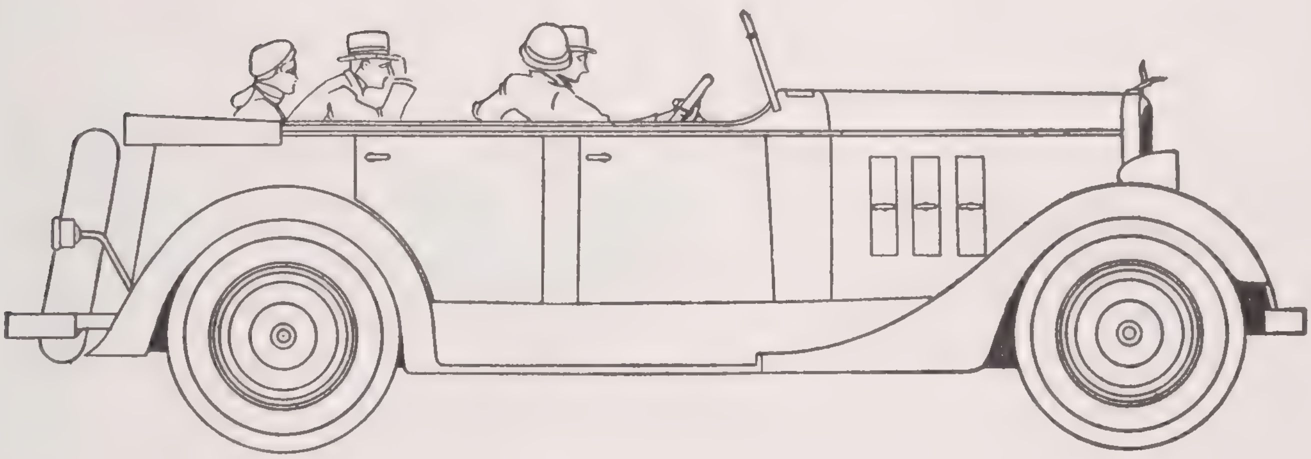


FIG. 357. — Give Book a Circular Motion and See the Car Run.

a circular motion, at the same time looking steadily at the center of the picture, and the wheels will immediately appear to revolve and the automobile to run.

By cutting out a side view of an automobile from a magazine or newspaper advertisement and mounting it

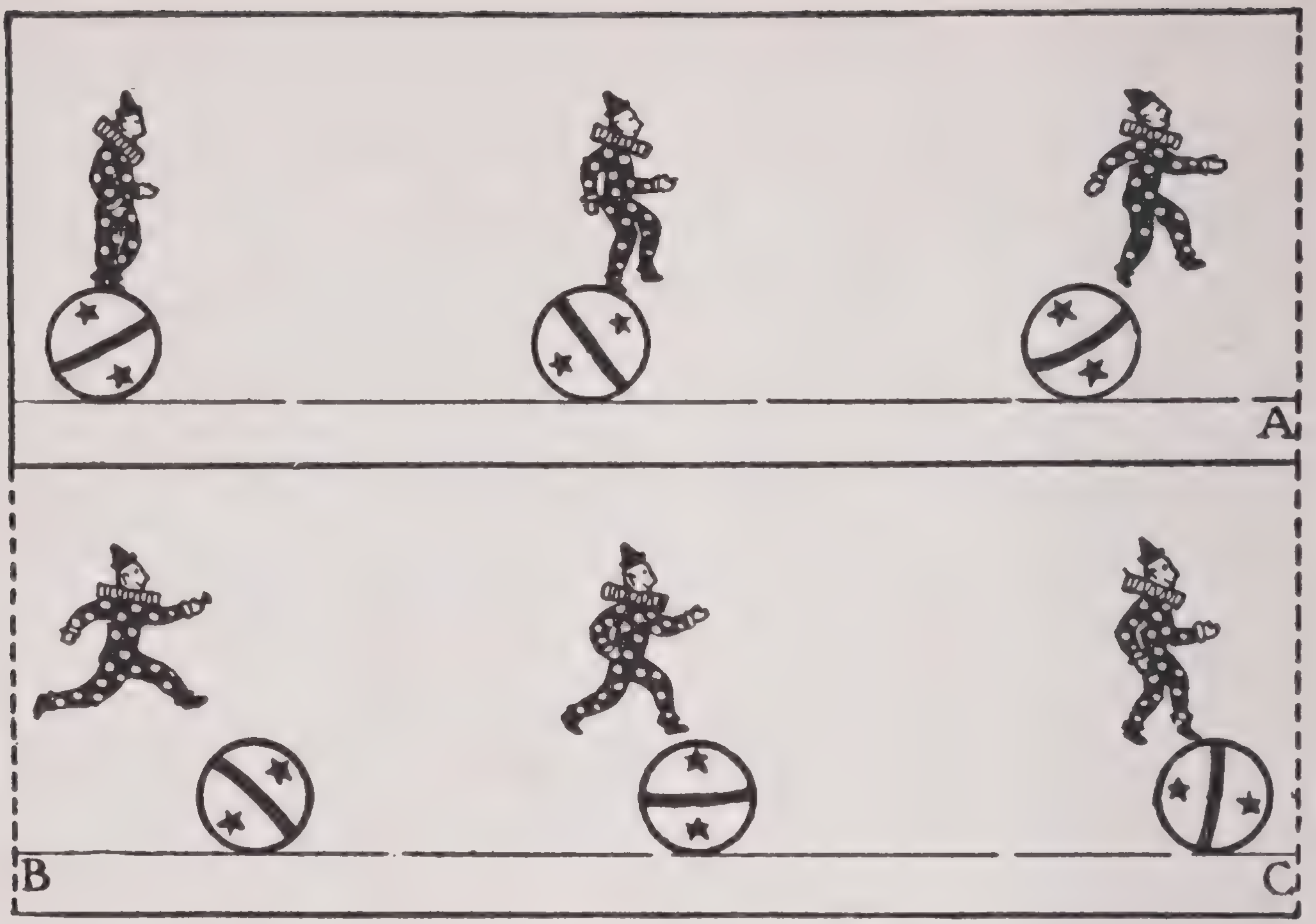



FIG. 355. — Moving Picture Set No. 1.

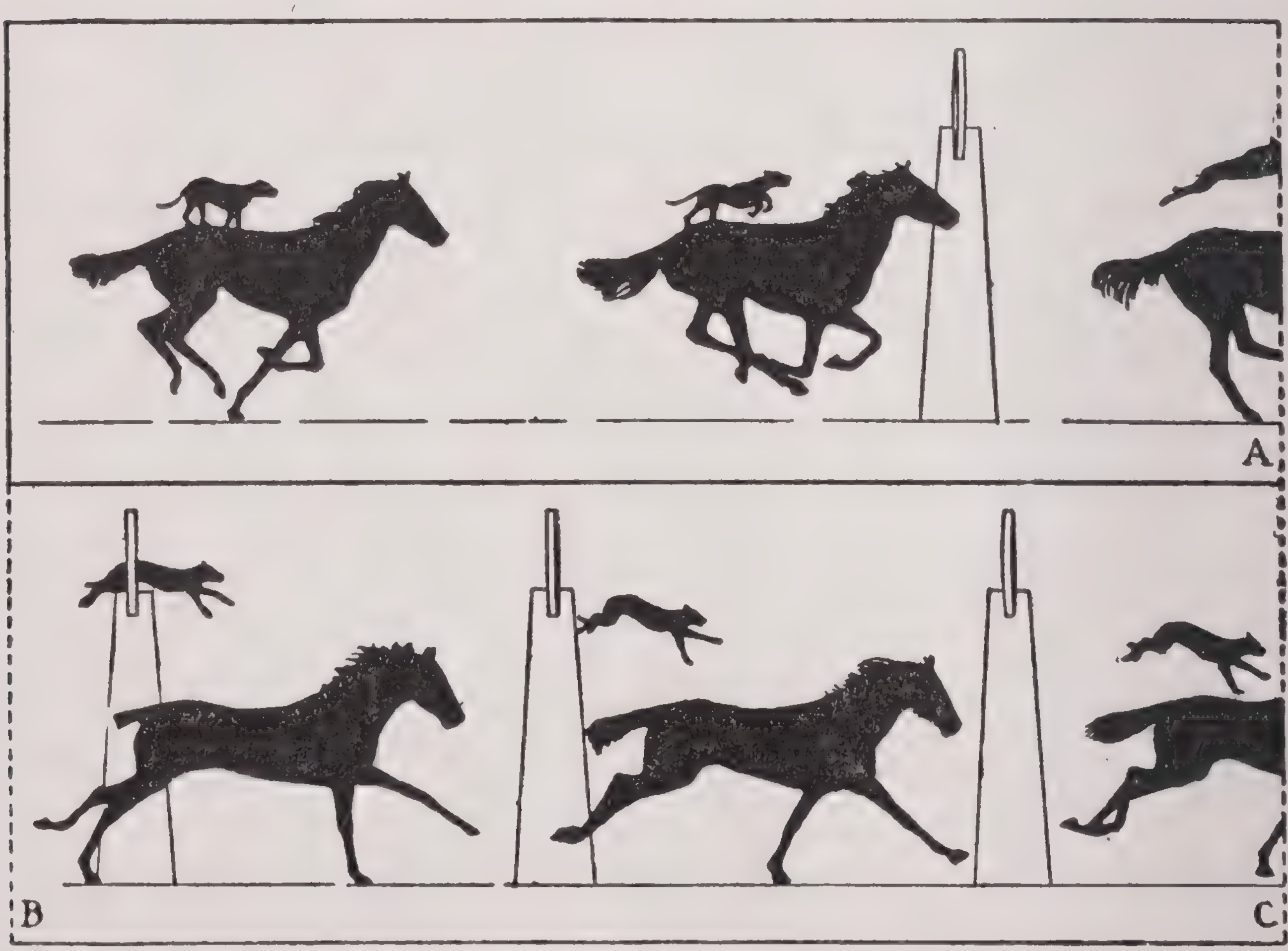
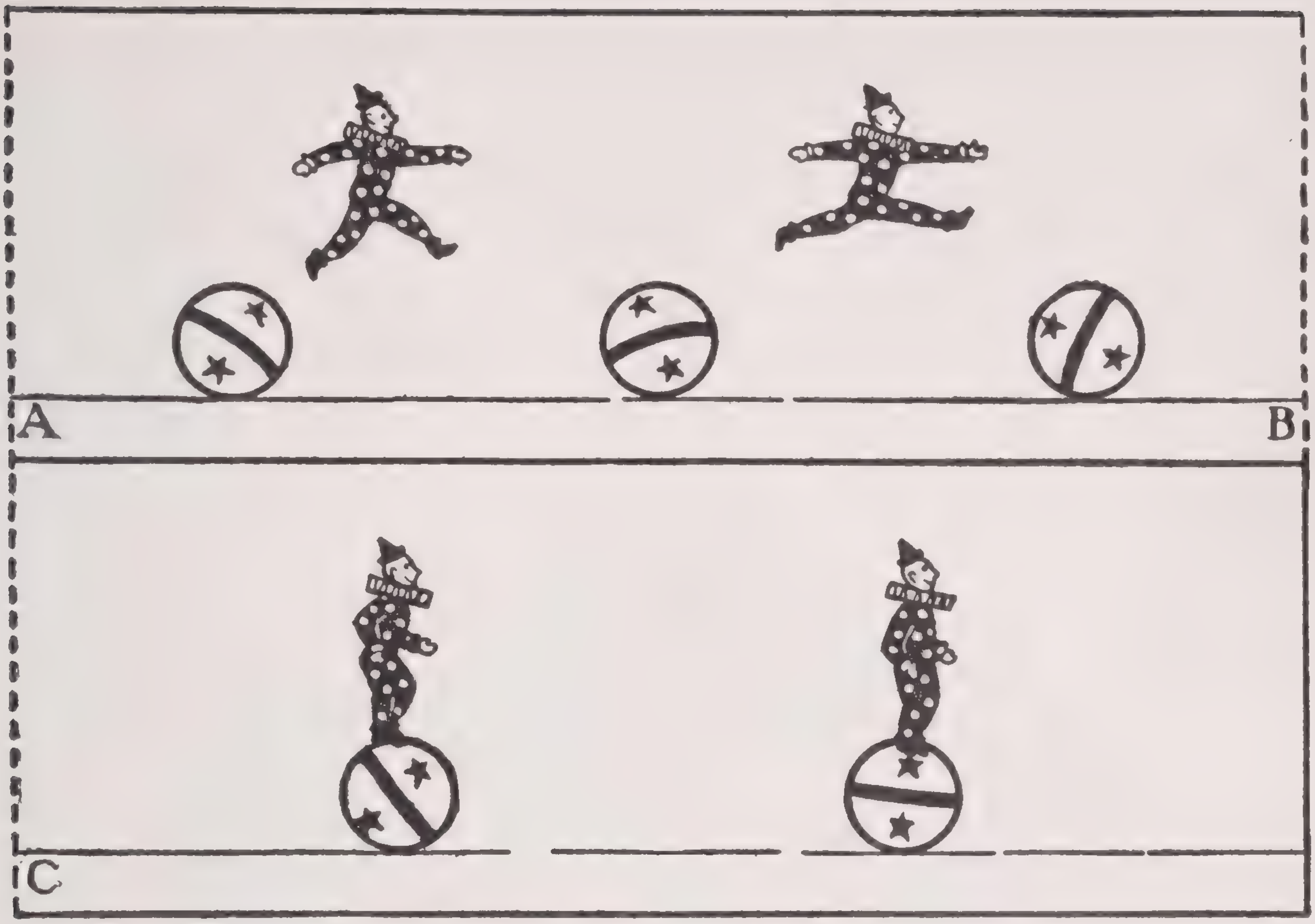
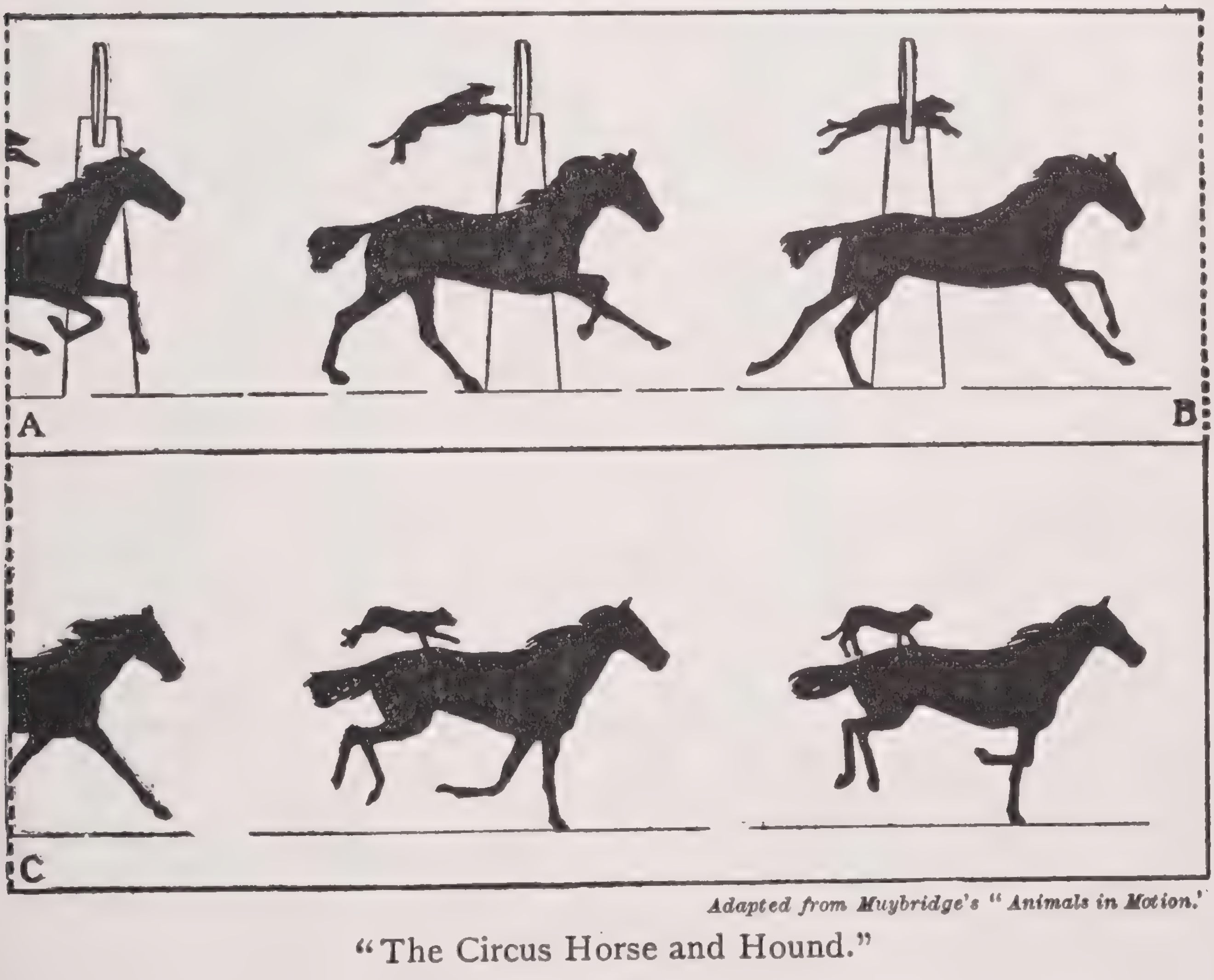



FIG. 356. — Moving Picture Set No. 2.




"The Clown and Ball."




*Adapted from Muybridge's "Animals in Motion."*

"The Circus Horse and Hound."

upon a piece of cardboard, then preparing two circular disks of the same size as the wheels with a series of concentric circles inscribed upon them as shown in Fig. 357, and pasting these over the printed wheels, you will have this optical illusion in a more convenient form to handle

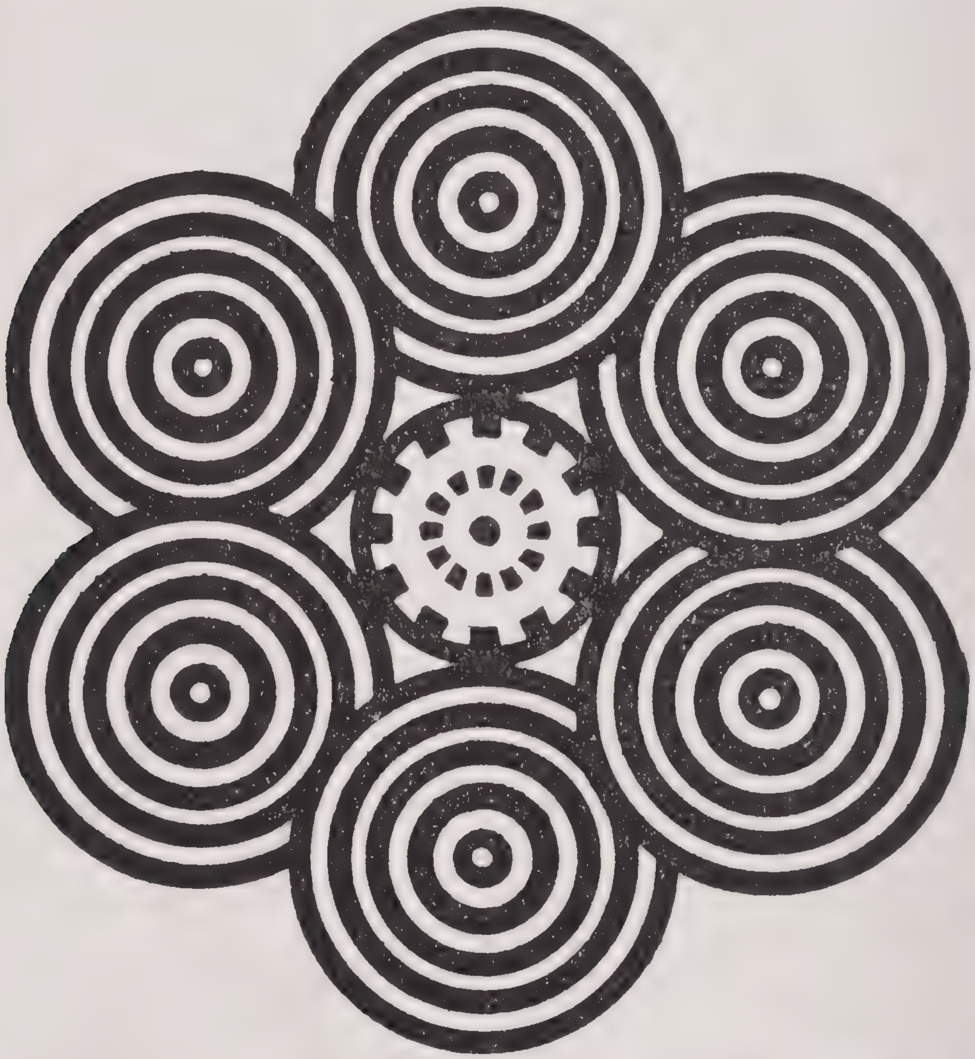


FIG. 358.—The Revolving Wheels. The inner wheel runs in the opposite direction from the outer wheels.

and in such shape that you can carry it about in your pocket to show to all your friends.

Another interesting optical illusion is

**The Revolving Wheels** shown in Fig. 358. By giving the book a circular motion and gazing at the center of

the illustration the outer wheels will begin to revolve rapidly, just as those of the automobile did, and the inner wheel will turn very slowly in the direction opposite to that in which the outer wheels run.

If you own a pair of compasses, you will find this illustration very easy to lay out upon a piece of paper or cardboard. The inner circle should be described first, then a larger circle upon which to locate the centers of the outer wheels should be drawn with the same center,

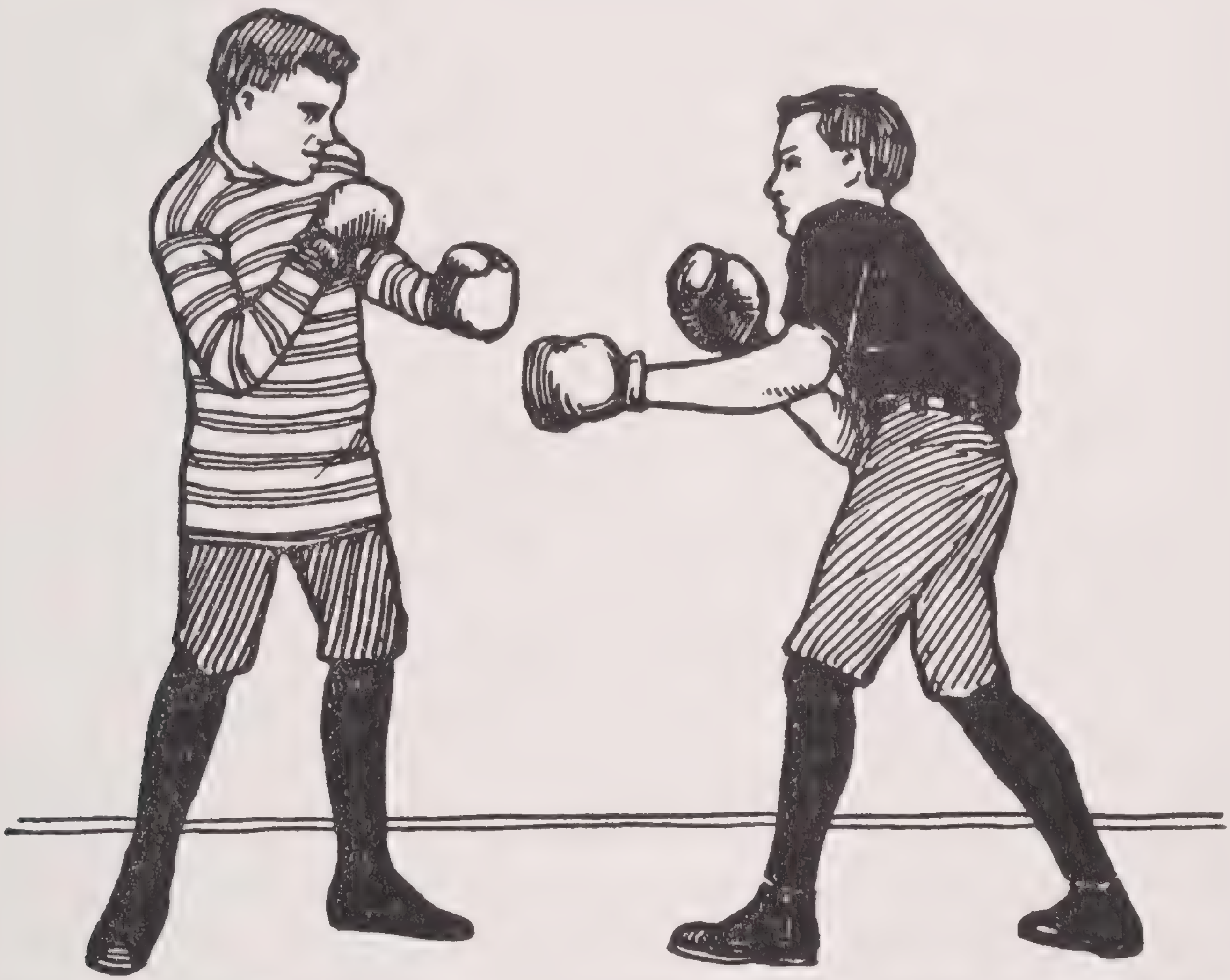


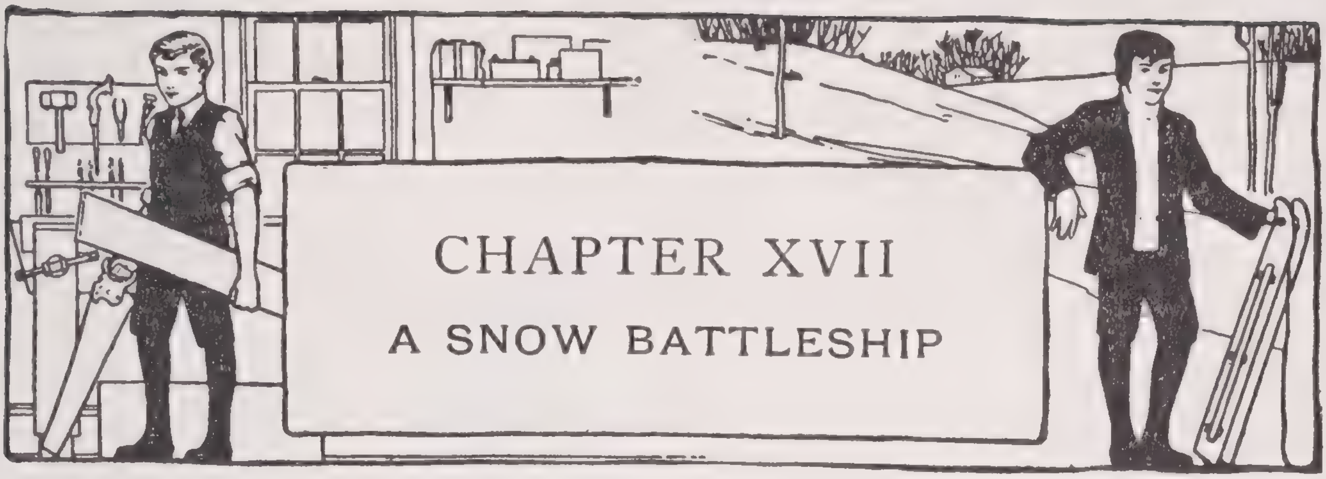
FIG. 359. — A Boxing-match. Gaze steadily at the center of the picture, draw the book up to your face, and the boys will appear to come together; lower and raise the book in succession, and you will see a lively boxing-match.

and the radius of this larger circle will be the proper spacing for the centers of the wheels.

An illusion of an entirely different kind but no less interesting is

**The Boxing-match** shown in Fig. 359. The directions for looking at this are printed below the illustration.

You may make cards with pictures of automobiles, motor cycles, and airplanes in similar positions, as it is easy to find side views of these machines in the advertisements in magazines; then when you have mounted these at the proper distance apart, you will have a set of moving pictures showing automobile and motor cycle smash-ups — which are now common occurrences — and airship collisions — which we will probably witness within a short time.



# CHAPTER XVII

## A SNOW BATTLESHIP

Here, boys, is a new idea for a snow fight. A snow battleship is, in construction, really a snow fort, with the addition of turrets, conning-tower, funnels, mast, and fighting-tops (Fig. 360). This extra equipment is easy to make and adds greatly to the sport of a snow fight. A little carpenter work is necessary, but this is simple to do, and all sawing and a good portion of the nailing may be done indoors. The pieces may then be carried to the spot on which you are going to build the ship and set in place.

The central portion of the ship, directly below the conning-tower and known as

**The Central Station**, requires a framework such as is shown in Fig. 361. Out of any boards you can get make two frames similar to that shown in Fig. 362, driving three or four nails through each corner and clinching their ends. The corners may be braced with diagonal strips, but this is not necessary, for the frames will be held rigid enough when embedded in snow. Cut two boards 3 feet 6 inches long for the cross-pieces *E*

and *F*, and enough boards of the same length with which to roof the top of the framework.

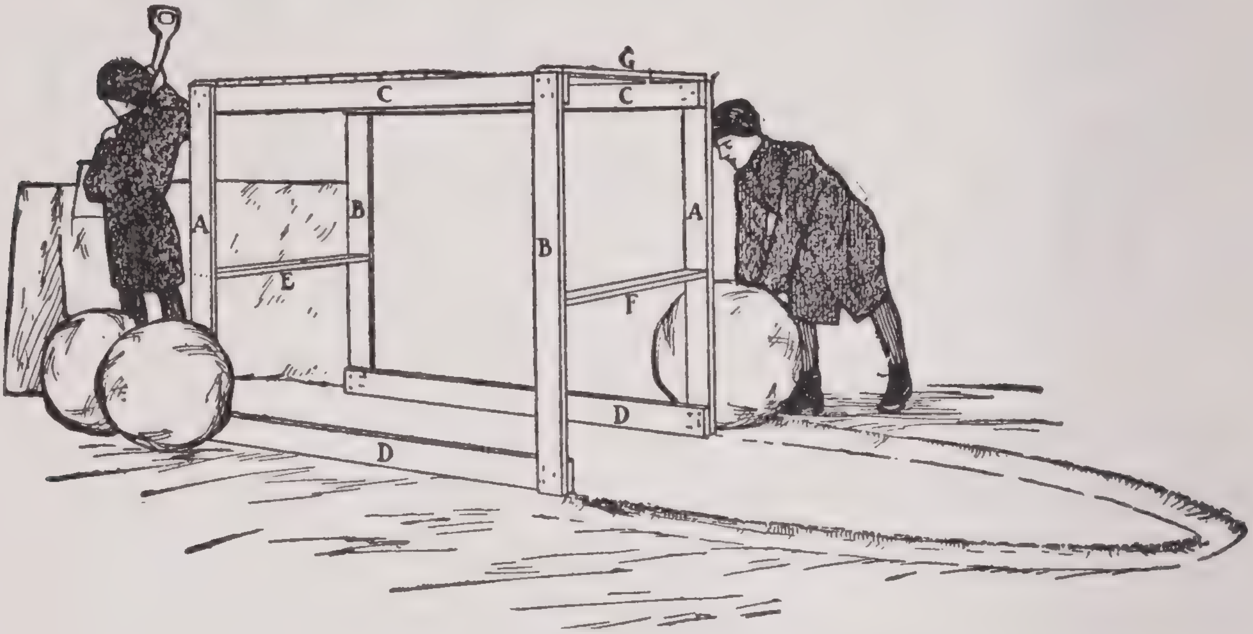



FIG. 361. — Framework of the Central Station.

On the site selected for the battleship set up the two frames as shown in Fig. 361; fasten the cross-pieces *E* and *F* between them 2 feet above the ground, and nail roof board *G* in place; leave a space of 22 inches for the conning-tower, then roof the rest of the top with the boards you have cut for the purpose (Fig. 361).

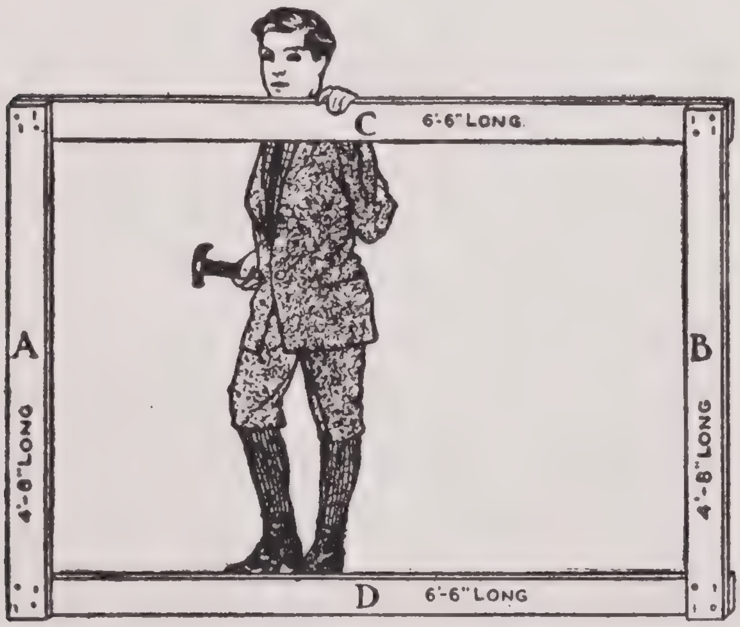



FIG. 362. — Make Two Frames like This.

If there is plenty of snow,

**Build the Hull** of your battleship alike on both sides, but if there is not enough

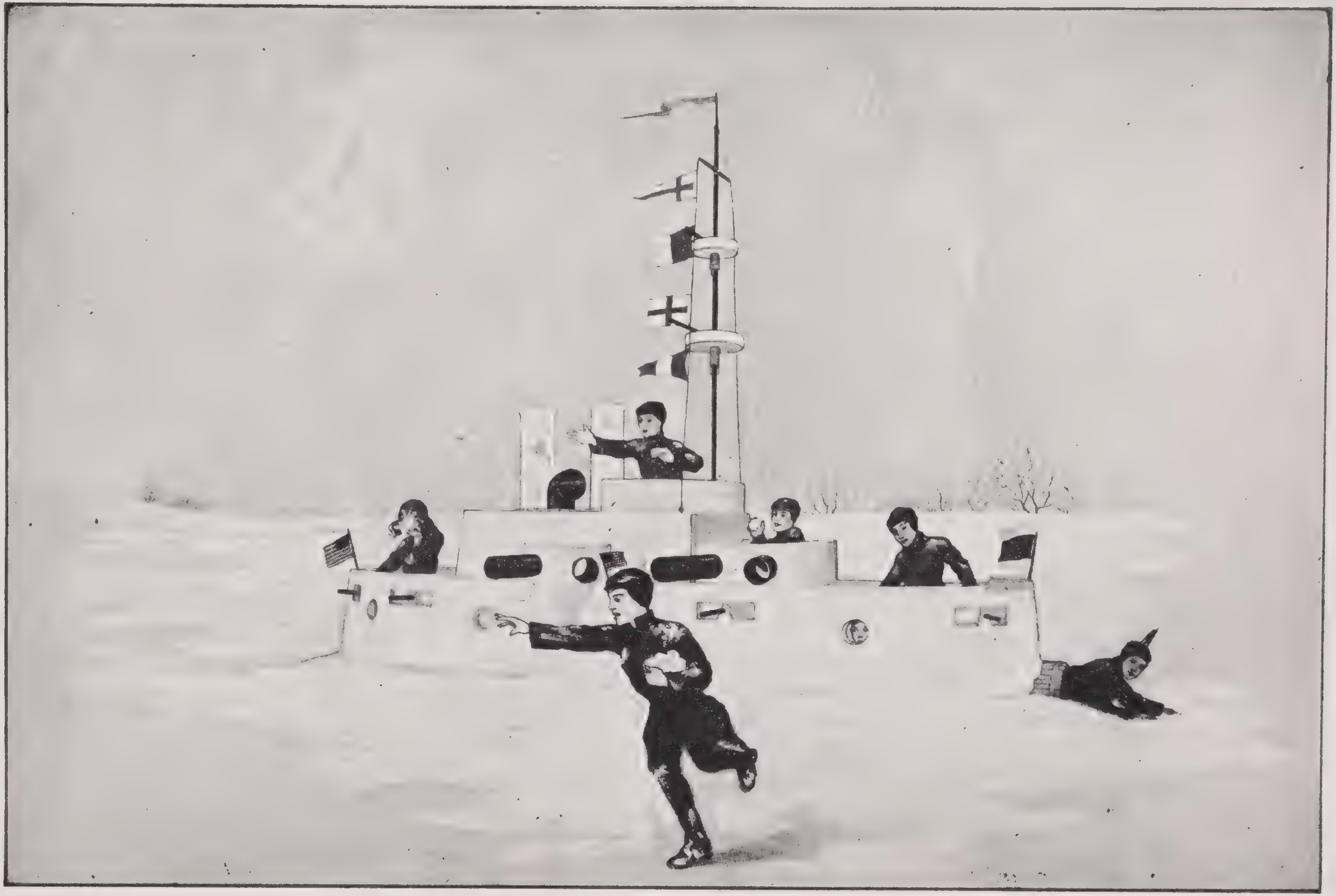


FIG. 360. THE "TORPEDO-BOATS" FURNISH THE ONLY MEANS OF ATTACK AT CLOSE RANGE.

to do this, stand the framework against the fence or wall and build only one side.

Figure 361 shows how the hull should be marked out in the snow with the sides converging toward the bow and stern. The inside of the bow should be about 7 feet from the central station framework, the inside of the stern about 4 feet from the framework. The illustration shows the stern end of the hull partly built up, and by this you will see how the sides should taper from a thick base to a thinner wall at the top. The inside of the walls should be straight, so as not to make the inside space too small, but you will find it much easier to build the wall roughly and then finish it off with a shovel afterward.

Set a barrel in the bow for

**A Torpedo Tube** (Fig. 363), and when the sides have reached a height of 30 inches, set the ends of a 4-foot board in them 2 feet forward of the central station (see *H*, Fig. 363) upon which to build the forward turret; at the same height set two or three boards into the walls inside of the framework, at *I* (Fig. 363), for the conning-tower platform. Build up the sides of the hull to a height of 3 feet 6 inches, and inclose the framework of the central station with a 5-inch wall of snow, leaving a passage fore and aft below cross-pieces *E* and *F* (Fig. 363) wide enough to crawl through. Offset the wall above the hull a trifle.

Cover the top of the central station —

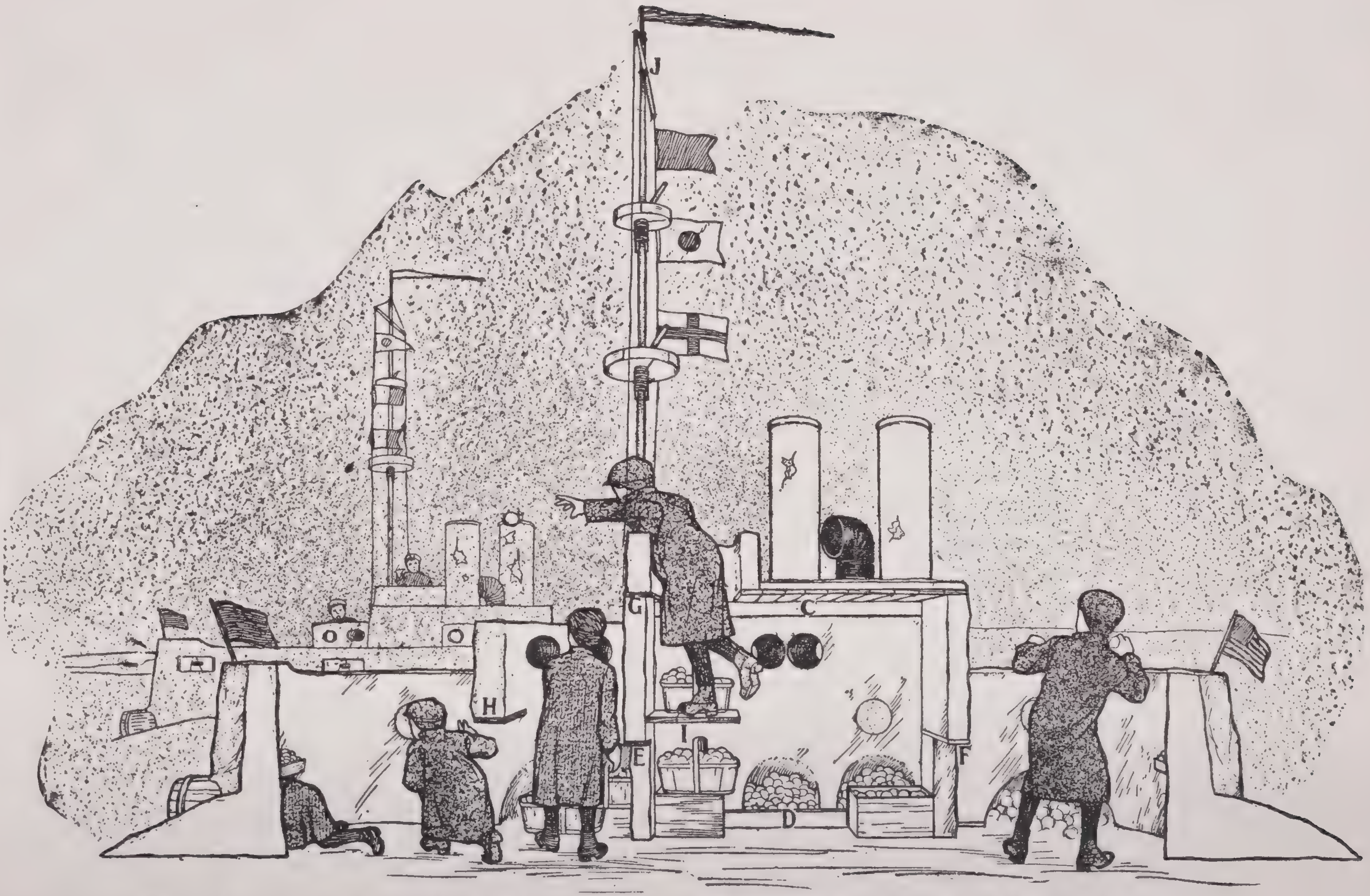



FIG. 363.—Two Battleships in Action, showing a Longitudinal Section of One Battleship.

**The Superstructure Deck** — with enough snow to hide the boards. Build the wall of

**The Conning-tower** 12 inches above the superstructure deck (Fig. 363), and that of

**The Forward Turret** 12 inches above the sides of the hull; build

**The Midship Turret** on to the side of the ship. The shaping of the conning-tower and turrets can be done with a shovel or a shingle. To lessen the apparent height of the hull, bank snow around the base (Fig. 363).

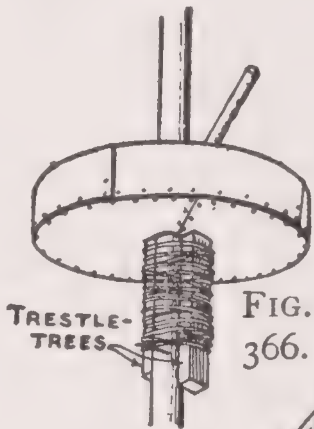



FIG. 366.

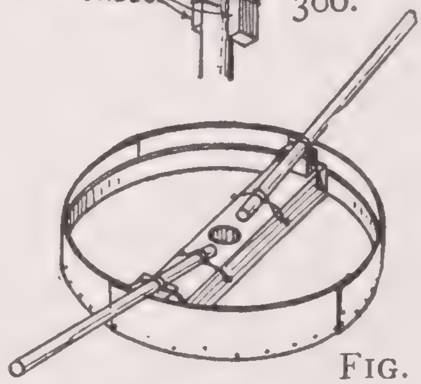


FIG. 365.

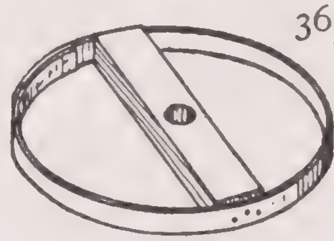


FIG. 364.

FIGS. 364, 365, and 366. — Construction of the Fighting-tops.

**The Mast** should be about 11 feet long and can be made by splicing together a couple of curtain- or clothes-poles.

**For the Fighting-tops** (Fig. 366) take two barrel-hoops, fasten a piece of 2-by-4 in each (Fig. 364), and bore a hole in the center large enough for the mast to slip through. Tack a 4-inch rim of cardboard around the hoops and cover the bottoms with the same material (Figs. 365 and 366). Wire pieces of broom-handle to the cross-pieces for

**Rapid-fire Guns** (Fig. 365). The fighting-tops should be supported upon *trestletrees* — two blocks of wood tied or nailed to the mast (Fig. 366).

Fasten the upper top 3 feet below the masthead, and the lower one 2 feet 6 inches below that.

**The Crosstree** should be 2 feet long; tie it securely at its center to the mast at *J* (Fig. 363).

**Make a Coach-whip Pennant** out of wrapping-paper or cloth to fly from the masthead, and to one of the *maststays*, which should be fastened to the masthead and to the ends of the crosstree, fasten three or four

**Paper Signal Flags** (Fig. 363). Pictures of these flags, in color, may be found in an encyclopedia.

After rigging up the mast, run it 18 inches into the wall of the conning-tower and tie the ends of the maststays to stakes driven into the snow.

**Make a Union Jack** for the bow of the ship and

**A National Ensign** for the stern, and tack them upon sticks for staffs.


FIG. 367. Framework of the Funnels.

**The Construction of the Funnels** is shown in Fig. 367. Unfasten four barrel-hoops and make them 12 inches in diameter, and cut twelve sticks 3 feet 6 inches long. Nail the sticks to the inside face of the hoops (Fig. 367), then cover the framework with heavy wrapping-paper. Place these funnels upon the deck as shown in Fig. 363, and pack enough snow around their bases to hold them in position. For

**Ventilators** procure a couple of stovepipe elbows.

Stovepipe or pieces of fence-posts may be used for your

**Main-battery Guns**, two of which should be placed in each turret. Cut three 8-inch *portholes* in the sides of the hull for peepholes, and make four depressions or recesses, as shown, for the

**Secondary-battery Guns**, which may be pieces of broom-handle.

Figure 363 shows the interior of your ship while in action. This illustration will suggest

**The Arrangement of Amunition Stores**, the idea being to keep the main supply of snowballs in baskets and boxes in the central station — the *magazine* — and from these to fill the pockets and baskets in the turrets and on the deck.

**The Captain of the Ship**, whom you must choose beforehand, will command from the conning-tower (Fig. 363), and must appoint the other men to their respective places on the forward deck, in the forward turret, the central station, and aft. He also selects the boy *torpedo boats*.

**For a Naval Battle** there should be at least two ships built with broadsides opposite (Fig. 363). Of course you can have a land and naval battle if the enemy prefer to build a fort, but there will be more fun with battleships. Certain

**Rules must be observed** in a snow fight, just as in any other boys' game, and the rules for a naval battle will differ somewhat from those of a snow-fort battle.

The main object of this game is to inflict as much damage as possible upon the enemy's ship (nothing but snowballs being allowed), and to capture and sink the "torpedo boats." A battleship is sunk if its mast is knocked to the ground. If neither ship is badly disabled when it is necessary to discontinue action for any reason,

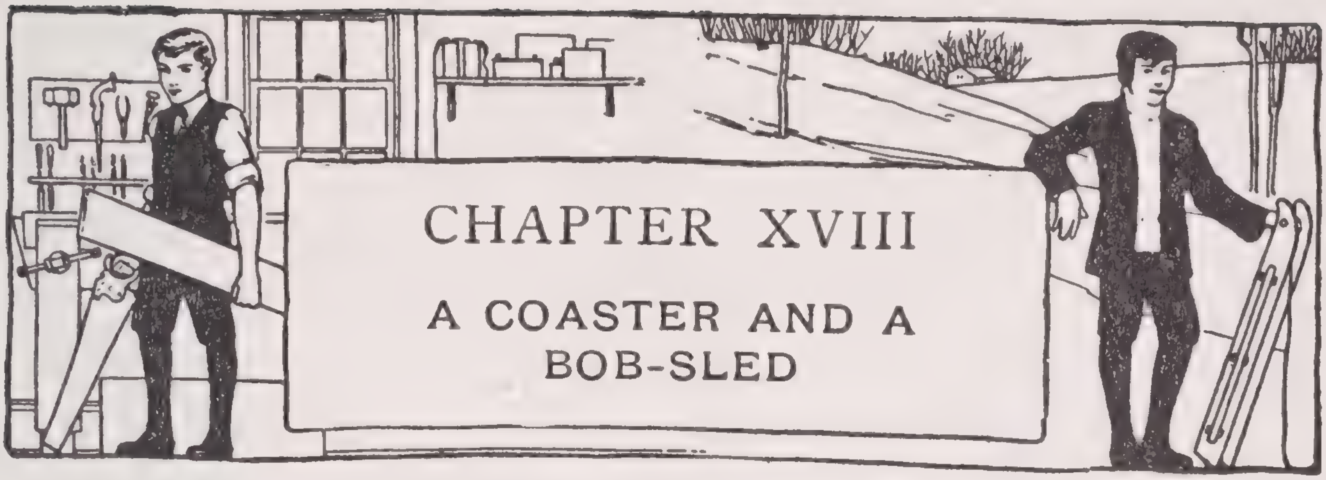
**A White Flag of Truce** should be displayed by each side, and during this period of truce you can all set to work and repair the ships.

**The "Torpedo Boats"** furnish the only means of attack at close range. Each side should have two of these — two boys who must each wear a small flag stuck in his cap, as shown in Fig. 360. The "torpedo boats" must not fire upon one another, but if the flag is knocked from the hat of one boy and a "torpedo boat" of the enemy reaches him before he can replace his flag, he is considered captured, sunk, and out of the game until his side captures an enemy's "torpedo boat," when an exchange may be effected.

**Repairs.** The paper-covered funnels, the fighting-tops, and the signal flags will be damaged the most and will have a fine battered appearance. These may easily be removed, carried indoors, and repaired in a few minutes.

In this kind of snow fight

**Good Marksmanship** counts for more than strength, and the small boy with an accurate aim is as valuable a man as his big brother.



# CHAPTER XVIII

## A COASTER AND A BOB-SLED

A HOME-MADE sled that is properly put together generally outlasts the store sled, not because it is more substantially built, perhaps, but because the boy who has spent the necessary time to construct it realizes its worth and takes a pride in keeping it in good condition.

**The Coaster** shown in Fig. 368 is simple to make, but in cutting out the various pieces and putting them together

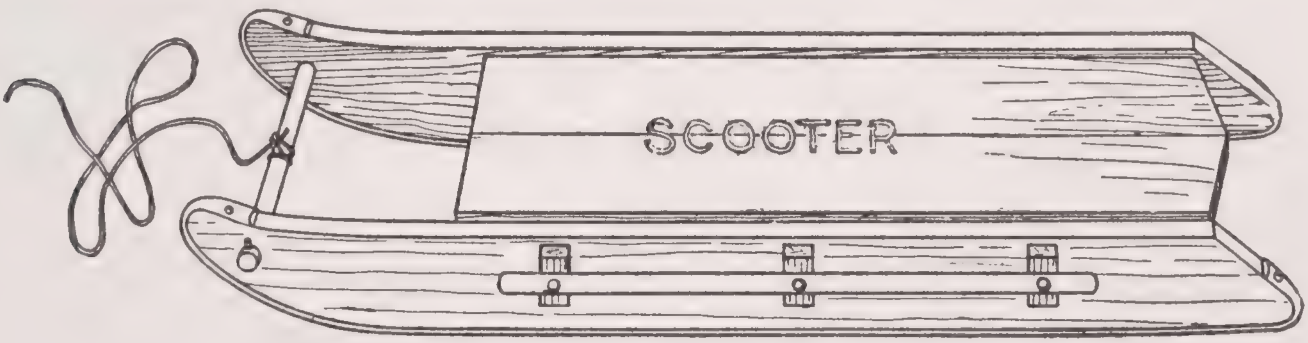



FIG. 368. — A Home-made Coaster.

you must do the work carefully in order to get the best results.

**Lay out the Runners** by the pattern shown in Fig. 369. This has been marked off into squares, at the ends, to aid you in laying out the curves. Measure off the total length of the runner upon a 1-inch or $1\frac{1}{4}$-inch board,

then lay out the squares as shown, spacing the lines 1 inch apart, and locate the points where the curves intersect the lines on the pattern; then it will be a simple matter to connect the points by a continuous curved line. After one runner has been laid out and cut from the board it can be used for a pattern for marking out the other runner. If you can get only pine or other soft wood out of which to cut the runners, you can reënforce them after cutting them out by driving 16-penny nails, or short pieces of iron rod, into holes bored vertically 8 or 10 inches apart.

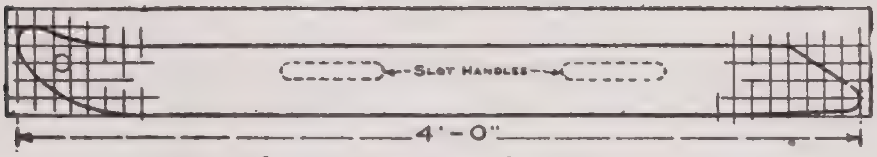


FIG. 369. — Pattern for Runners.

(Lay out the squares as shown 1" × 1" as a guide for drawing the curved ends.)

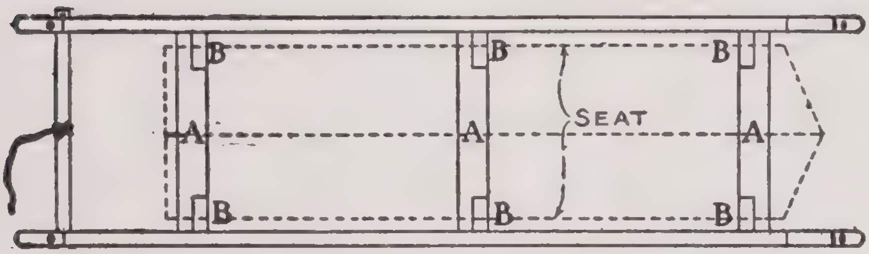


FIG. 370. — Plan of Runners and Cross-pieces.

Oiled wooden runners will slide over an icy surface, but **Shoes** either of *hoop-iron* or *half-oval iron* are to be preferred if you can get them. A blacksmith is the man to go to for these. Take the runners to him and have him bend the irons to fit and make the screw holes so you can screw them in place. The holes along the bottom should be countersunk so the screw-heads will set flush with the iron (Fig. 376). Five screws for each runner will be plenty.

Cut the three

**Connecting Cross-pieces** (*A*, Figs. 370 and 371) 12 inches long, 2 inches wide, and $1\frac{1}{2}$ inches thick and prepare the ends of each as shown at *A* (Fig. 372); then cut the six braces *B* (Figs. 370 and 371) as shown in Fig. 372, to fit the mortises in the ends of *A*. Screw the braces to the cross-pieces and to the runners (Fig. 371), then screw the cross-pieces between the runners. They should be $\frac{7}{8}$ inch below the top — one 11 inches from the front end, another 7 inches from the rear end, and the third halfway between the two.

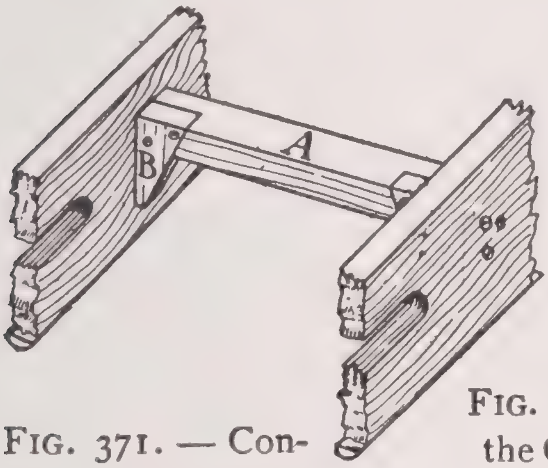



FIG. 371. — Connect the Runners like This.

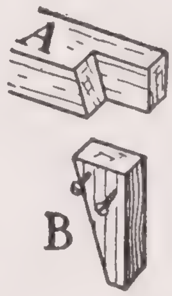



FIG. 372. — Cut the Cross-pieces and Braces like This.

**Make the Seat** in two pieces (a wide board would be likely to split) and screw the boards to the cross-pieces.

There are a number of forms of

**Sled Handles**, any one of which you may use. One of the simplest kind of handles consists of slots cut through the runners as shown in Figs. 369 and 371. The slots should be cut as described on page 142 (see Fig. 156). To make the handle shown in Fig. 368, cut two pieces of broom-handle 28 inches long and four wooden blocks 2 inches square; nail two of the blocks to each runner, then bore $\frac{5}{8}$-inch holes through the broom-handle pieces and through the blocks and runners, and bolt the handles

in place with $\frac{5}{8}$-inch carriage-bolts 4 inches long. Drawer-pulls, such as are used upon the fronts of kitchen pantry drawers, are another form of handles which may be used.

FIG. 373.—"Every boy can own a bob-sled."

Bore a 1-inch hole through the bow ends of the runners and cut a piece of broom-handle to fit in them for

**The Foot-bar.** If you drive a nail through each end of the broom-handle, close to the runners, it will prevent the bow end of the runners from spreading.

**Paint** your coaster with at least two coats of paint. You may suit yourself about the colors, but a good combination would be to paint the runners yellow or green and the seat and handles red; then if you want to letter a name upon the seat, put it on with black paint.

Every one of you boys can own **A Bob-sled**, for there is nothing difficult about constructing one, and the material required is inexpensive.

A bob consists of two sleds built

along the lines of a coaster, placed tandem, and connected with a plank long enough to hold three or more boys (Figs. 373 and 374).

The sleds must be built first, and as they are identical in construction

**The Four Runners** may be cut out by the same pattern (Fig. 375). The pattern shows the curved ends marked

FIG. 374. — A Home-made Bob-sled.

off into squares, just as the pattern for the runners of the coaster was shown, and one runner should be laid out first, just as described for the other sled, and the others marked out from this. Make them out of oak or other strong wood, if possible, as the bob-sled's runners are subjected to a great deal of strain. If you must use soft wood, do not fail to reënforce them as suggested for the runners of the coaster.

**For connecting the Runners** and bracing them, cut six cleats $1\frac{1}{4}$ inches thick, 2 inches wide, and 10 inches long (*A*, Figs. 376 and 378), and buy twelve 2-by-2-inch iron angle-braces, such as are shown in Fig. 377, at a hardware store. Nail the runners to the ends of the cleats, using three cleats for each sled and spacing them as shown in Fig. 378, and then screw the angle-braces to the runners and to the cleats (Figs. 376 and 378). Cut

**The Sled Seats** 22 inches long out of 10-inch boards and screw them to the cleats.

**The Seat of the Bob-sled** shown in the illustration is a 2-by-10-inch plank 7 feet 6 inches long and is bolted to the bow sled and hinged to the stern sled. Cut the two

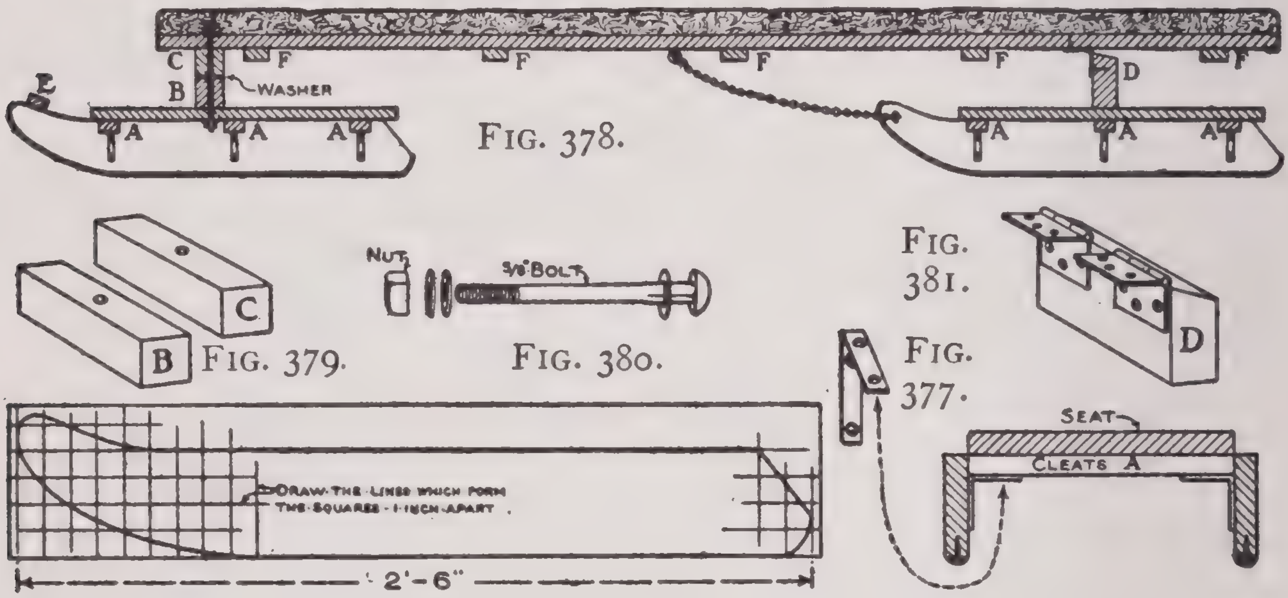



FIG. 375. FIG. 376.

FIG. 375. — Pattern for Runners.
FIG. 376. — Cross-section of Sled showing how Runners are Braced.
FIG. 377. — Iron Braces for bracing the Runners.
FIG. 378. — Longitudinal Section of Completed Bob-sled.
FIG. 379. — Blocks for connecting Seat to Front Sled.
FIG. 380. — Use a $\frac{5}{8}'' \times 7''$ Carriage-bolt for a King-bolt.
FIG. 381. — Block for connecting Seat to Rear Sled.

blocks *B* and *C* (Fig. 379) $1\frac{3}{4}$ inches wide, $1\frac{3}{4}$ inches thick, and 10 inches long, and bore a $\frac{5}{8}$-inch hole through the center of one side of each, then bolt block *B* to the board seat of the sled and block *C* to the under side of the plank, and bore the $\frac{5}{8}$-inch holes through both the board seat and the plank. Buy a $\frac{5}{8}$-inch carriage-bolt 7 inches long (Fig. 380) and drop it into the holes in the

plank, block, and sled seat, putting a washer between the bolt-head and seat, another between blocks *B* and *C* and a washer and nut upon the lower end.

**The Seat is hinged at the Stern End** so the stern sled will rise and fall as it runs over uneven ground, independent of the bow sled. Cut block *D* (Figs. 378 and 381) out of hard wood 2 inches thick, 4 inches wide, and 10 inches long, and plane off the top edge as shown. Get a pair of 4-by-4-inch wrought-steel butts at a hardware store for the hinges, and bolt them to this block and to the plank seat with screws $1\frac{3}{4}$ inches long; then spike the stern sled to the block. Connect the bow ends of the runners of the stern sled with the bottom of the plank seat with

**Check-chains**, or ropes, fastened to screw-eyes (Fig. 378).

**Cut the Steering Foot-bar** *E* (Fig. 378) 20 inches long, nail it to the runners of the bow sled, and attach

**The Steering Lines** to its ends (Fig. 374).

**For Handle-bars** cut the cross-bars *F* (Fig. 378) 20 inches long and screw them to the under side of the plank seat, and bolt pieces of broom-handle to their ends, as shown in Fig. 374.

**The Seat should have a Cushion** and an old automobile chair, or boat cushion may be remodeled for it, or the top of the plank may be padded with excelsior or straw and then covered with a piece of oilcloth or carpet (Fig. 378). The padding should be spread out evenly and be

secured to the plank by stretching a piece of cloth over it and tacking it to the edges of the plank with cord before putting on the top covering (see directions for upholstering on page 116); then the covering should be pulled tight over the padding and tacked to the under side of the plank. *Tufting* the cushion every 4 or 5 inches, by driving nails through the covering and padding into the plank, will prevent the padding from shifting and becoming lumpy (Fig. 374).

**Two Coats of Paint** applied to all the woodwork will give the sled its finishing touches, then, with a snow-covered hill or slippery toboggan-slide to coast upon, you will be ready to give all of your friends a ride upon your new home-made bob.

**Other Winter Sports Equipment.** You will find other plans for sleds in Chapter XXII of "The Boy Craftsman," in Chapter XVIII of "The Handy Boy", Chapter XXVI of "Carpentry and Mechanics for Boys", and Chapter XV of "Big Book of Boys' Hobbies". The single-runner coaster in Chapter XVIII of "The Handy Boy" will interest you, I know, and you will want to build the skatemobile described in Chapter XV of "Big Book of Boys' Hobbies". It has ice-skate runners.

If there is no hill for coasting, build a toboggan slide like the one in Chapter XXII of "The Boy Craftsman", or the simpler slide in Chapter XXV of "Carpentry and Mechanics for Boys".

It is natural to turn one's attention from sleds to

speedier craft. You will find a small skate-sail in Chapter XV of "Big Book of Boys' Hobbies", larger rigs in Chapter XLII of "Outdoor Boy Craftsmen", and an excellent ice-yacht in Chapter XLI of "Outdoor Boy Craftsmen"

Have you ever owned a pair of skis? Try the pair of barrel-stave skis in Chapter XV of "Big Book of Boys' Hobbies". Then shape a pair of standard design from the plans in Chapter XLII of "Outdoor Boy Craftsmen".

When you build the snow battleship described in the preceding chapter of this book, you will want a periscope like the one in Chapter XXVII of "Carpentry and Mechanics for Boys". For modern snow battles you will want the tanks, mortars and shields described in Chapter XLIII of "Home-Made Games and Game Equipment".

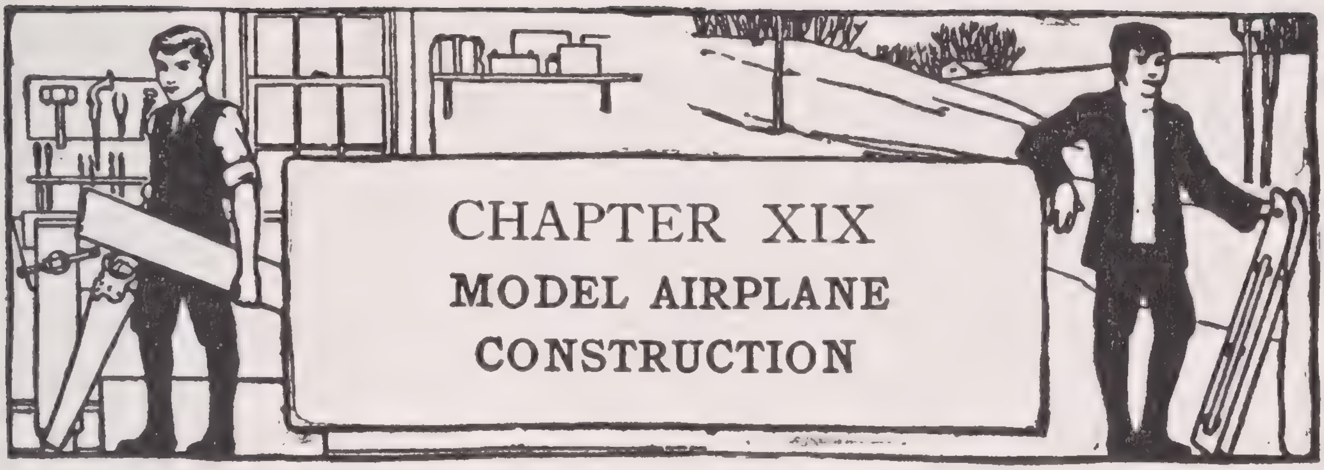
Modeling in snow is fun. Try a snow totem-pole like that in Chapter XV of "Big Book of Boys' Hobbies".

Follow the plans in Chapter XL of "Home-Made Games and Game Equipment" for making ice-hockey equipment. The snowball target and snowball tenpins in the following chapter of the same volume, are less strenuous games.

Have you ever gone fishing in winter? Suggestions for tip-up signals, and for a fishing shack are given in Chapter XLIII of "Outdoor Boy Craftsmen".

# PART II

# Spring and Summer Handicraft



# CHAPTER XIX
## MODEL AIRPLANE CONSTRUCTION

If you have never built a model airplane, you cannot imagine the thrill that you will experience upon the occasion of your first ship's initial flight. True, it may not be much of a flight. That would require skillful tuning and launching that comes only by patient practice. The important thing will be that you have built a model that flies. Your reaction will be one of renewed confidence in your mechanical ability, and increased enthusiasm for model making.

This chapter has been prepared with the idea of getting you off on the right foot, if you are a beginner, and of giving you pointers for improving your building methods, if you are already a builder.

We shall first take up

**Methods of Wing Construction.** The photographs in Fig. 382 show five forms of construction. Wing *a* is of sheet balsa, wings *b*, *c*, *d* and *e* have built-up balsa frames and are to be covered with tissue-paper. Wings *a*, *b* and *c* are of extremely light weight. The all-balsa wing *a* measures $1\frac{3}{4}$ inches wide and 12 inches

long, and it weighs one twenty-fourth of an ounce. The built-up wing *b* measures $2\frac{3}{4}$ inches wide and 12 inches long, and it weighs one sixty-fourth of an ounce. Wing *c* measures $3\frac{1}{4}$ inches wide and 20 inches long, and it weighs one-fortieth of an ounce.

**The All-balsa Wing** is given camber by cementing two cambered ribs across its center, as shown in Fig. 385.


FIG. 385. — Balsa Wing with Ribs Shaped to give Wing Camber, and to Make Slip-Fit over Stick Motor-Base.

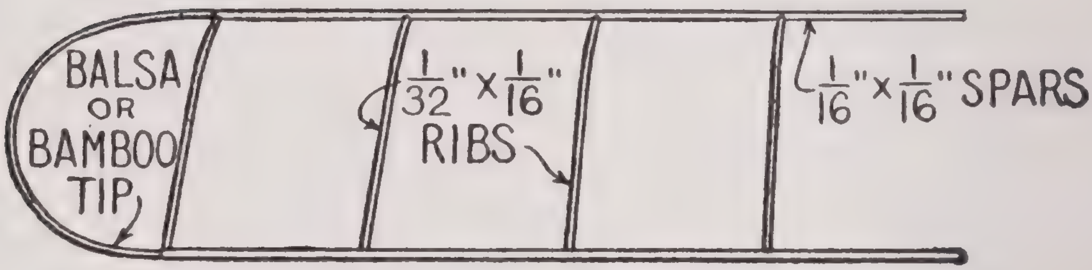



FIG. 386. — Wing Framework for Single-Surface Papering.

The ribs are spaced the right distance apart to make a slip-fit over a stick motor-base, or fuselage. The wing is held to the motor-base, or fuselage, by means of rubber wing-bands. This wing is used on the PFG-33 Glider Model described in Chapter XXIX.

**The Built-up Wing Frames** *b* and *c* in Fig. 382 are of the single surface paper type. One has square tips, the other has curved tips. The spars and ribs are of balsa. The curved tips may be of balsa or bamboo (Fig. 386).

**Cutting Balsa** into strips $\frac{1}{32}$ or $\frac{1}{16}$ inch wide for spars and ribs is easy, provided that you have sheet balsa of the correct thickness. Use a safety-razor blade to cut with, guiding it by a straight edge, as shown in Fig. 387. A carpenter's steel square is a good straight-edge for this work. Do not attempt to rip balsa into strips with any type of hand-saw. The only successful means is a saw of the speed of the circular-saw.

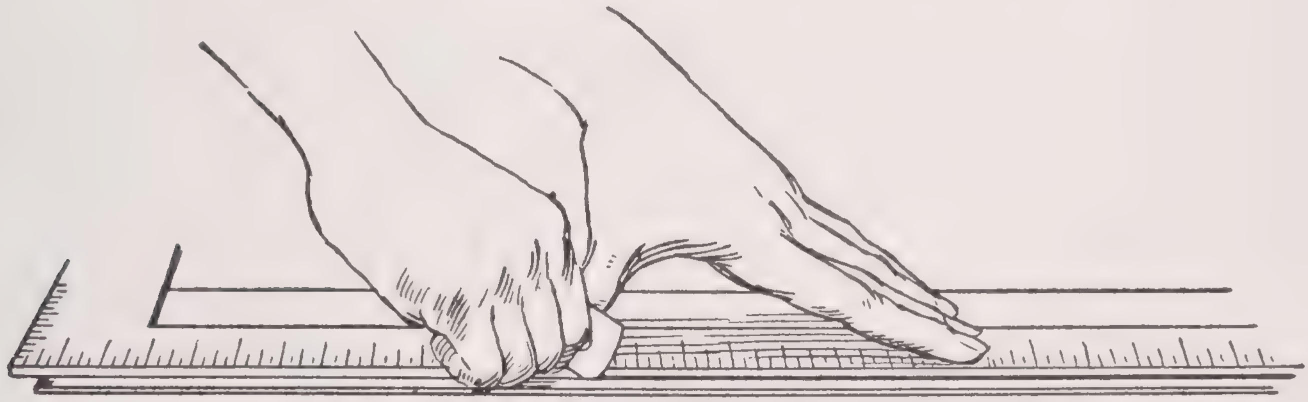


FIG. 387. — Rip Balsa into Strips with Razor Blade Guided by Straight-Edge.

**Split Bamboo Into Strips** with a sharp knife. You can cut across the grain with your coping-saw.

**Wing Camber** requires cambered ribs. The ribs may be shaped either in the cutting or by bending. Figure 388 shows how you can cut them from a piece of sheet balsa. Cut ribs are not as strong as bent ribs, because they split easily at the points where the grain crosses them. Figure 389 shows how you can bend ribs over a block that has been cut of the correct form, and Fig. 390 shows how you can shape them in a metal jig. The jig is easier to make than the block form. Use a piece of tin from a can. Steam the ribs over

the spout of a teakettle to make them pliable, and hold them over the form, or leave them in the jig, until the wood has dried. Then they will retain their shape.

**The Wing Tips** may be shaped in the same way as the ribs. Balsa tips may be steamed, then bent over

FIG. 388. — Ribs Cut with a Camber.

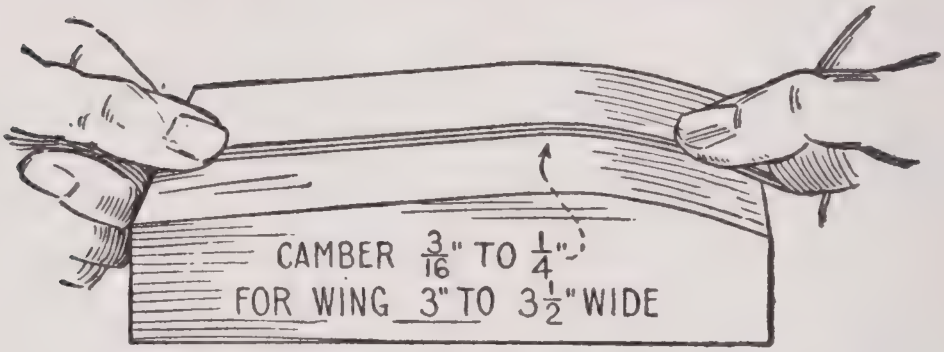



FIG. 389. — Block Templet for Shaping Ribs.

FIG. 390. — Metal Jig for Shaping Ribs.

the side of a tin can. Bamboo requires heat to make it pliable for bending. A much used method for bending bamboo strips is to hold them over the flame of a candle (Fig. 391). Another method is to bend them over a lighted electric-light bulb.

**Wing Assembly.** It is easier to assemble a wing in two sections (Fig. 392a) than to bend the spars at

the center to form the dihedral angle wanted. Therefore, cut the spars one half of the length of the wing span, less the tip radius. Cut the ribs of equal length, with ends square. To assemble, place the spars upon a flat surface, tip the rib ends with cement, press them against the spars, and hold them until the cement has set. Determine what the rib spacing will be, and

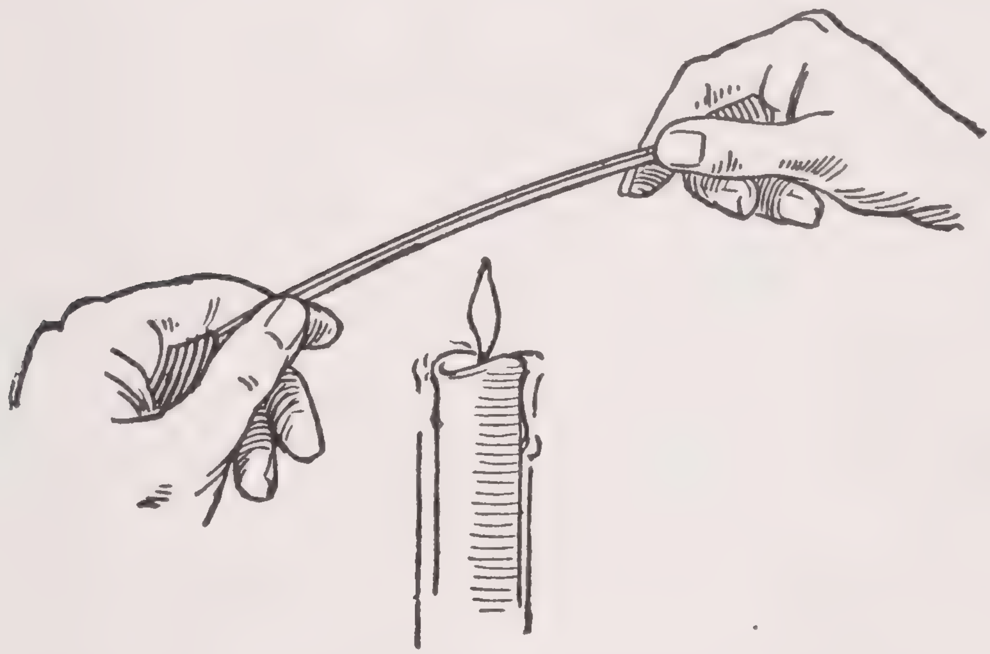


FIG. 391. — Bending Bamboo over a Candle Flame.

cut a strip of wood to the correct length for a spacer. The spacer strip will make it easy to get equal spacing, and it will speed the assembly. Make certain that each rib is placed at right angles to the spars, so that the wing frame will be symmetrical. The wing-frame halves shown in Fig. 392a have four ribs each, which, with a center rib, make nine ribs for the completed frame. A larger number of ribs will make a stronger framework. Notice that the wing of the model shown

in the frontispiece has fifteen ribs. When the ribs have been assembled, cut, bend and attach the wing tips.

To join the wing halves, place them upon your bench with the tips blocked up as shown in Fig. 392b, so that the distance between the bench and the end ribs is $1\frac{1}{2}$ inches. This will give the correct dihedral angle for a wing of 24 inches span. But notice that the entering wedge of the left tip is blocked up an addi-

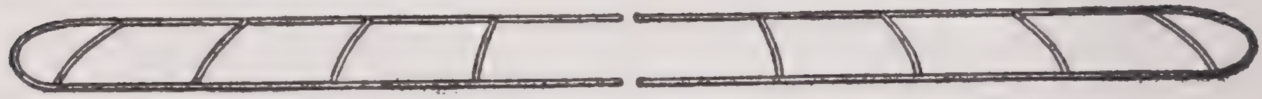


FIG. 392a. — Assemble Wing in Two Half-Sections.


FIG. 392b. — Block up Wing to form Dihedral Angle, Bevel Inner Ends. Cement together and Attach Center Rib.

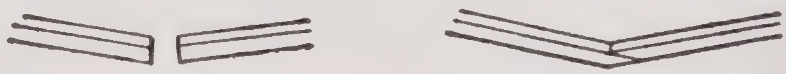


FIG. 392c. — Bevel Wing Inner Ends in One of These Ways.

tional $\frac{1}{4}$ inch, making the distance between the bench and end rib $1\frac{3}{4}$ inches. This is done to give the left half of the wing a *wash-in*, which is necessary to offset the torque produced by the propeller, assuming that the propeller will be a right-hand propeller, turning counter-clockwise (facing the direction of flight).

Figure 392c shows two methods of trimming the spar ends, for joining them. The joint at the left is easier to make, the joint at the right is the stronger.

Coat the trimmed ends with cement, bring them together, and hold until the cement has set. Then cement the center rib between the spars.

**Double-surface Wing Frames** are shown in detail in photographs *d* and *e* of Fig. 382. In frame *d* the ribs consist of upper cambered ribs and lower straight ribs. In frame *e* the ribs are of one piece, of the type shown

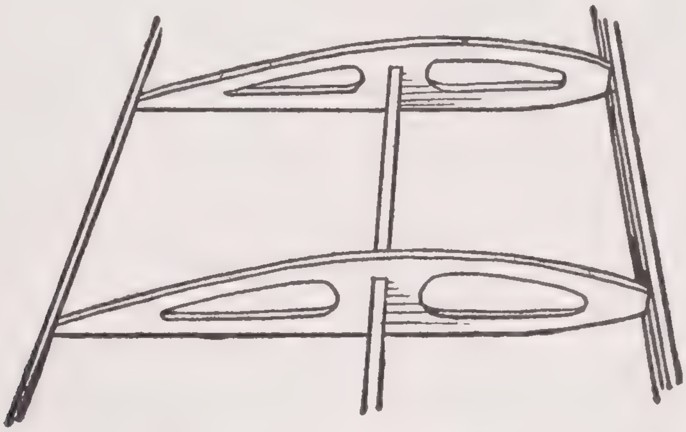


FIG. 393a. — Wing Construction for Double-Surface Covering.

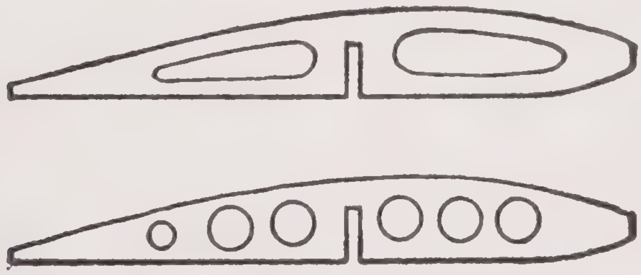


FIG. 393b. — Ribs for Double-Surface Wing.

in Fig. 393a. The latter are easier to assemble and they make a stronger wing. They are heavier, it is true, but weight is reduced by cutting away the center, as shown in Fig. 393b, either by making elliptical slots or round openings. The round holes can be punched with the end of a pencil-eraser ferrule, or with a piece of thin tubing filed sharp on one end. A quick way

to cut a series of ribs is to saw them out on a jig-saw. Cement together half a dozen pieces of balsa, cut of the correct width and length, draw the rib outline upon the top piece, and saw the six pieces at one time. Sand the edges and then separate the pieces.

A good test of one's skill in model building is his job of

**Wing Covering.** If this is neatly done, the paper made tight without wrinkles, and without drawing the framework out of shape, it is safe to assume that the

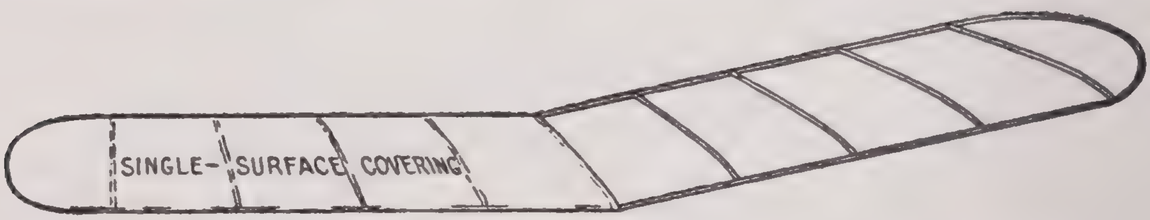



FIG. 394. — Paper One Half of Wing, then the Other Half.

builder is a good mechanic, and that he can turn out a shipshape model of any type that he may tackle. Covering a wing is about the hardest step in model building. A large proportion of failures can be traced to carelessness. Skill in papering will come with careful workmanship and practice. But the success of the job depends largely upon the wing framework. The frame members must be of sufficient cross-section to support the covering material. Tips and opposite portions must be alike, and all parts must be set parallel, at right angles, or at such angles as the plan specifies.

The photographs in Fig. 383 show three types of wings. For

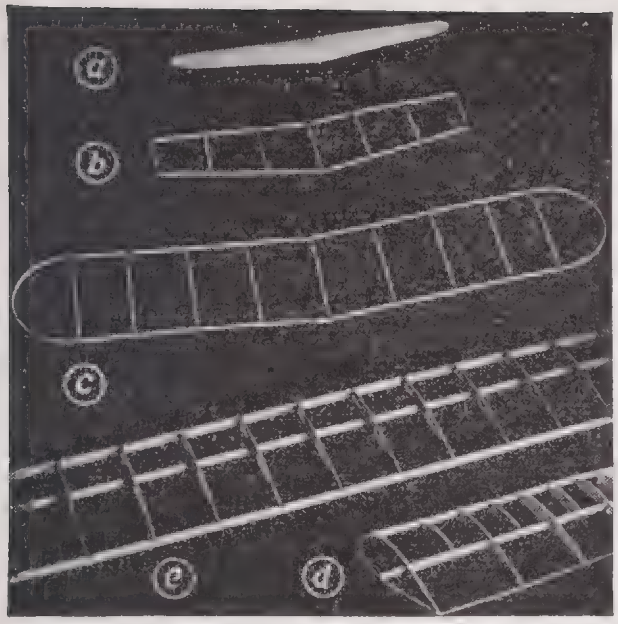



FIG. 382.—FIVE TYPES OF WING CONSTRUCTION.

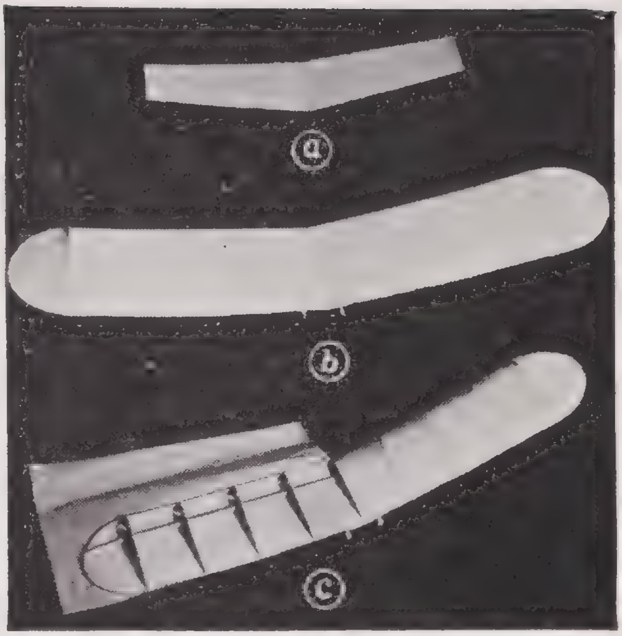



FIG. 383.—THREE TYPES OF WINGS PAPERED.

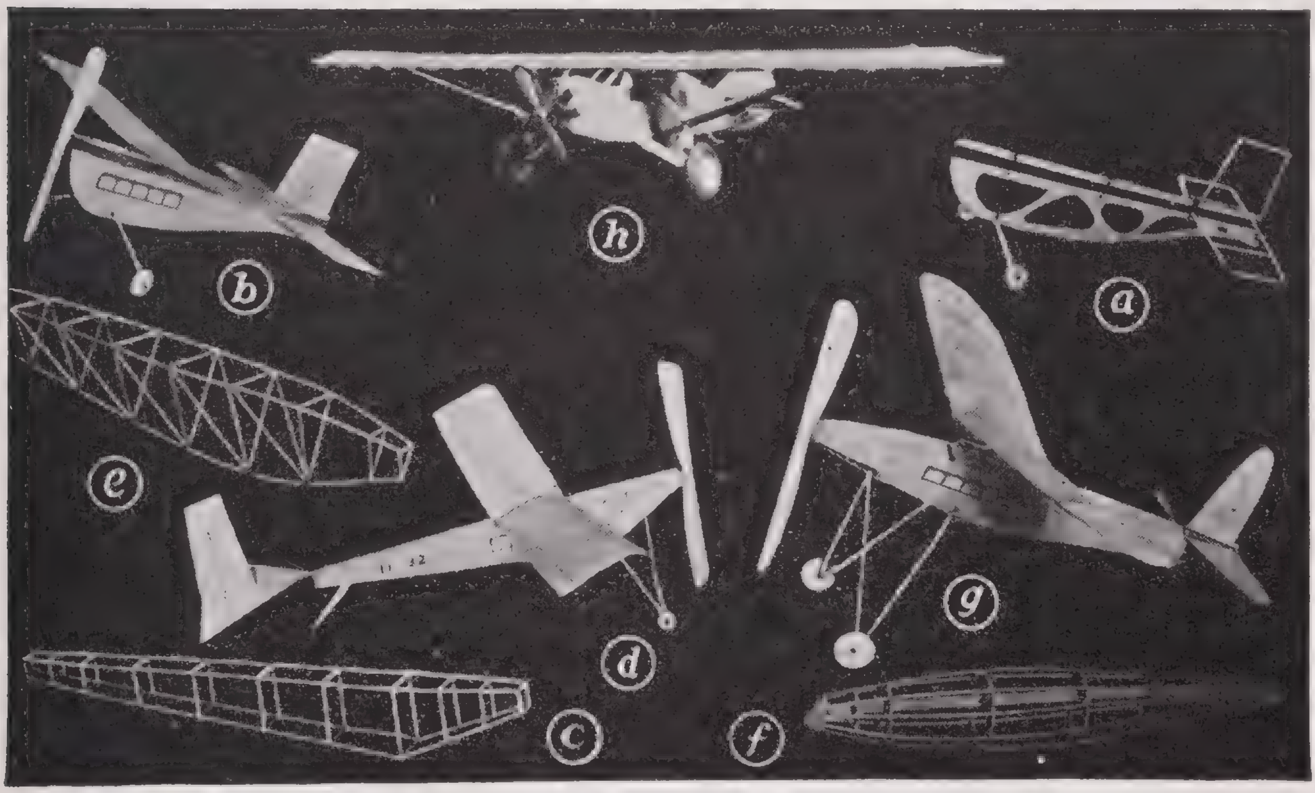



FIG. 384.—FIVE TYPES OF FUSELAGES.

**A Beginner's First Job of Papering,** the small wing (Fig. 383a) is best, because it has straight ribs and square tips. Figure 382b shows its frame. You can build, the frame quickly, so, if the covering is not a success you can build another frame and try again. After papering that wing, try a wing like Fig. 383b, a single-

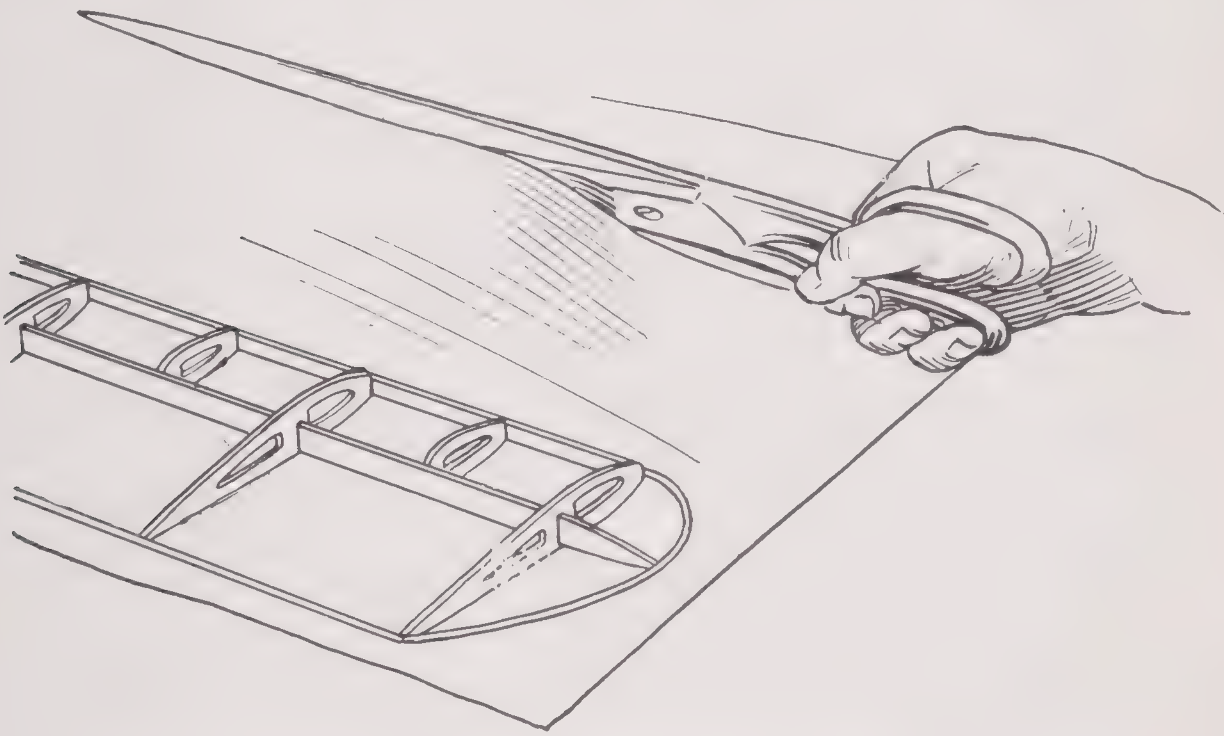


FIG. 395. — Cutting Tissue-Paper for Double-Surface Papering.

surface job. Then tackle a double-surface wing like Fig. 383c.

**Press the Japanese Tissue-paper** to be used for covering, if it is wrinkled. Use Mother's iron for pressing it.

**Cut the Tissue-paper** with scissors or with a safety-razor blade and straight-edge. You will need two pieces a trifle larger than one half of the wing frame.

**Banana-oil is the Adhesive** to use for attaching the paper. If your paint store does not carry it, you can get it

from any dealer in model-airplane materials. Apply it with a small brush to the spars and ribs (Fig. 396).

**Start the Papering** at the center rib and work towards a tip. After applying the banana-oil, lay the tissue-paper in place, pull it taut, and rub it down gently to

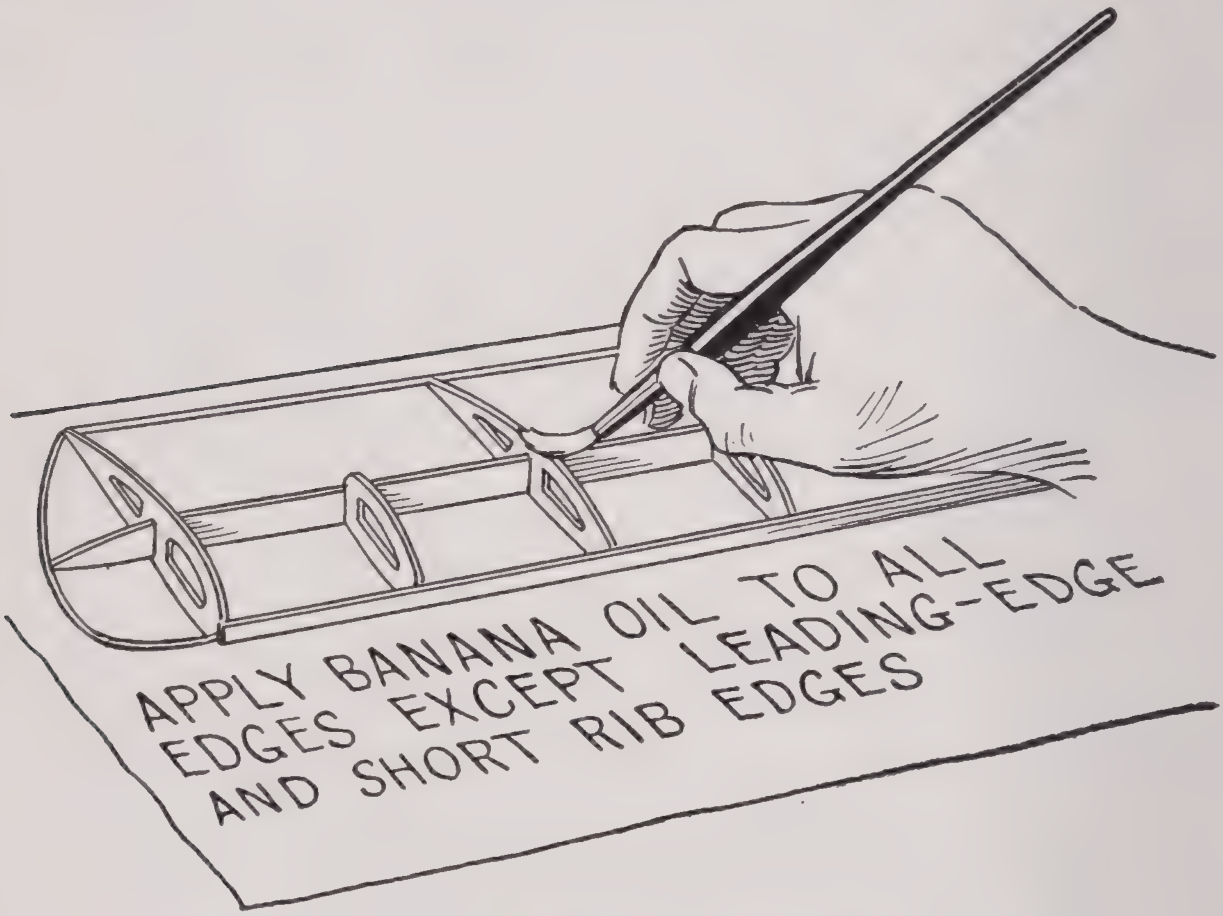



FIG. 396. — Applying Adhesive to Wing Framework.

work out wrinkles. When this piece has been applied, cover the second half of the frame with the second piece of tissue-paper.

**Trim the Projecting Edges** of the tissue-paper close to the spars and wing-tips with a safety-razor blade. Trimming is shown in Fig. 397. Smooth the trimmed edges with fine sandpaper.

Although you may have done a smooth job of papering, the surface will not be as taut as it should be, and you will have to

**Shrink the Tissue-paper** over the spout of a teakettle. This operation requires careful manipulation, because uneven steaming will cause unequal shrinkage, and too much steaming will shrink the paper and twist the framework out of shape. The amount of steaming must be ascertained by experimenting. Steam the paper slightly and let it dry, then steam it a little

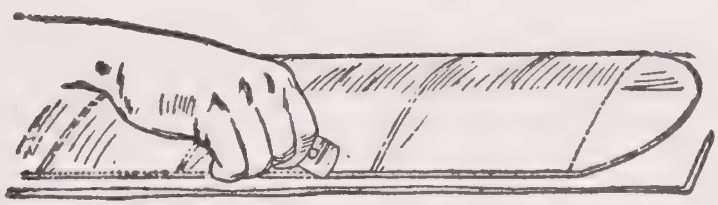


FIG. 397. — Trim off Projecting Edge with Safety-Razor Blade.

more, and again a little more, if necessary, until the surface is taut without wrinkles.

**For Double-surface Papering,** cut a piece of tissue-paper a trifle wider than is necessary to cover the top, leading-edge and bottom of the wing frame (Fig. 395). Attach the paper to the under side of the wing, first, bring it up and over the leading-edge, and cover the top. Apply banana-oil to the trailing-edge and the ribs (Fig. 396) but not to the leading-edge. When both halves of the frame have been covered, trim off the projecting edges (Fig. 397), then shrink the paper until it is smooth and taut.

**Fuselage Construction.** The flying-stick model airplane has the advantage of being stripped of nonessentials that add weight without contributing anything to flying efficiency. It flies like an airplane, but with the exception of its wing and tail parts, it lacks the lines of an airplane. It was devised in the early days of pioneering in model-airplane construction, when balsa wood was unknown to model builders,

FIG. 398. — A Profile Fuselage of Type Shown in Fig. 384A.

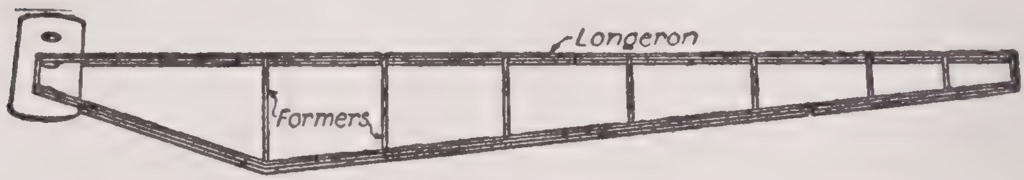



FIG. 399. — Build Opposite Frames, one upon the other, to get them alike.

and when the lightest material available for spars and ribs was spruce and bamboo. It served the purpose of affording boys a satisfactory medium for experimenting. With developments, including all-balsa frame construction, reducing weight to a fraction of an ounce, it is still a favorite for duration and speed contests. There is no better model for a beginner to build and fly. The IT-31 Indoor Tractor Model described in Chapter XXX is an excellent flying-stick model to build. In this day of scale-model reproduc-

tions, it is natural for the model builder to progress from flying-stick to fuselage models, then, from fuselage models to scale models built from authentic plans of existing ships. Photographs in Fig. 384 show five types of fuselage models, four of them with views before and after papering. These examples cover only a few developments, of course. All but one are of the lighter weight forms of construction, being stripped of parts non-essential to flying efficiency. The exception (Fig. 384h) is a one-twelfth scale model of the Travel-Air Cabin Monoplane.

**The Profile Fuselage** shown in Fig. 384a and 384b is the easiest type to build. Viewed from the side, it presents the same appearance as a full-fuselage model. An advantage, of course, is its light weight. The model illustrated is 10 inches long, and with its tail parts and landing-gear it weighs about one-sixth ounce. Another advantage of this blade-shaped fuselage is that it serves as a keel, imparting lateral stability. Figure 398 shows a detail of the fuselage. Complete plans for this fuselage model are given in Chapter IX of "Big Book of Boys' Hobbies." Plans for a profile-fuselage glider model are given in Chapter XXIX of this book.

**A Simple Built-up Fuselage** is shown in Fig. 384c and 384d. The frame is 16 inches long and weighs one-eighth ounce before papering. Figure 399 shows a detail of the assembled side frames, which are built

one upon another to get them alike. With the side frames built up, it is a simple matter to join them with the cross formers. Full directions for building this model are given in Chapter XXXI.

**The Wedge-shaped Fuselage** shown in Fig. 384e is a modification of Fig. 384c. It is 19 inches long and weighs one twenty-fourth ounce. First, build the top frame, cementing the former strips between the longerons. Build the triangular former frames upon this

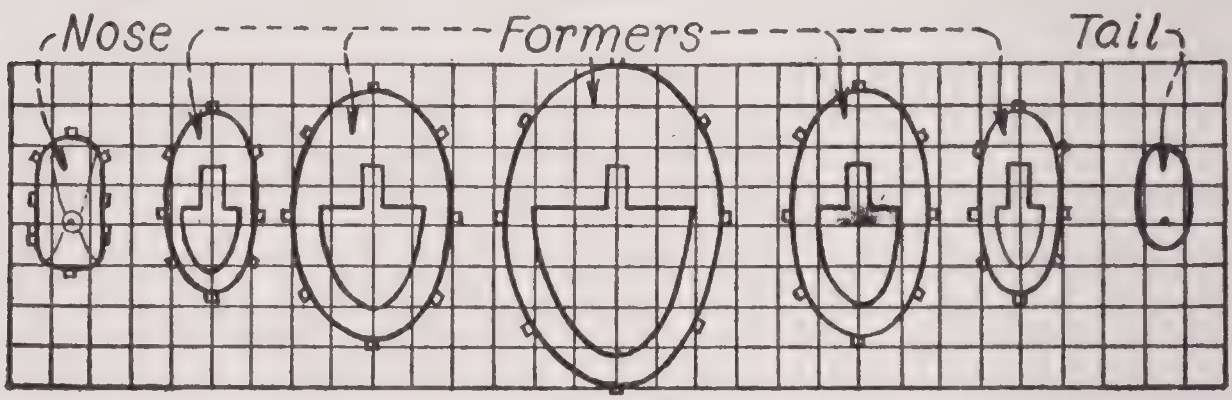



FIG. 400. — Nose, Formers, and Tail, for Fuselage of Type Shown in Fig. 384f.

top frame, then shape the lower longeron to meet the apexes of the formers, and cement it in place. Set in braces from the apex of each former to the upper corners of the former next in line. Great accuracy is required in setting up the formers, to make a symmetrical framework.

**The Oval-shaped Fuselage** shown in Fig. 384f and Fig. 384g is 16 inches long and weighs one-eighth ounce. It has six formers, a nose block and a tail block, cut out of balsa. Patterns are shown in Fig. 400, ruled

off into squares to give you the sizes. Each square represents a $\frac{1}{4}$-inch square of the full-size formers and blocks. This fuselage has eight longerons, and a center spine stick or motor-base. The nose block and the tail block are cemented to the ends of the spine stick. The formers are notched to fit over the stick, and their lower portion is cut away to admit the motor rubber. Mark off the spacing of the longerons on the edge of each former. Then the assembly will be simplified. Drill the nose and tail blocks to admit the propeller-shaft and motor-hook.

**Scale-model Fuselages** may be built up like that of the model in Fig. 384c and Fig. 384f. You must have scale drawings of the ship to work from. Fig. 384h shows a model of the Travel-Air Cabin Monoplane, built by reader Donald Ashcraft. Its frame is of wire with soldered joints. Plans and instructions for building three ships are given in Chapter XI of "Big Book of Boys' Hobbies." In building scale models, you will have an excellent opportunity to use your ingenuity devising engine cylinders, exhaust pipes, cowlings, workable parts, cockpit and cabin fittings, instruments and other accessories.

**Propellers.** Carving a propeller requires skillful whittling. With a block of the correct proportions for the model that you are building, it is no trick to lay out the blades and hub preparatory to carving. Propeller sizes and pitches for models have been pretty

well standardized, and you can purchase the size of block specified for the model that you intend to build, in blank form, sawed out, or completely shaped. Theoretically, the pitch of a propeller is the distance that the propeller should move forward in one revolution. It is dependent, therefore, upon the thickness, width and length of the block. Figure 401 shows several sizes of propeller blocks, marked off for carving. The dimensions in brackets may be substituted for three

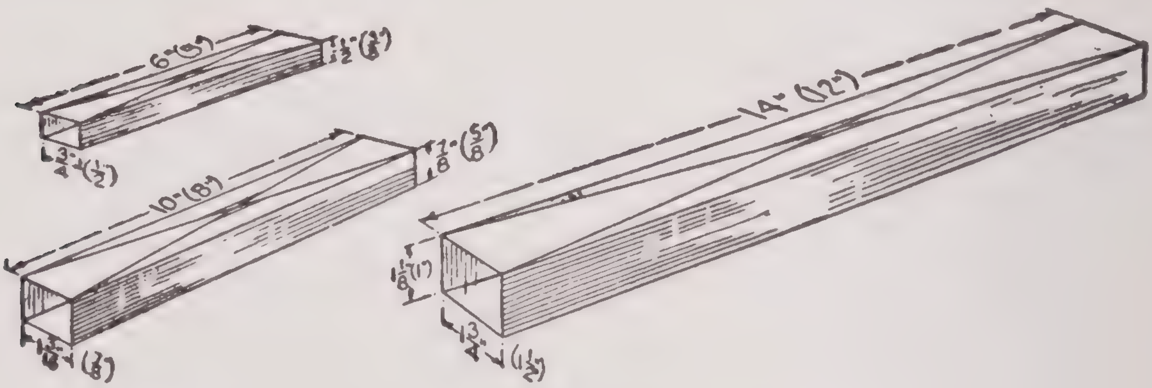



FIG. 401. — Dimensions for Propeller Blocks.

other sizes of propellers. Directions for laying out and carving propellers are given in Chapters XXX and XXXI.

**Wire Fittings** such as *propeller-shafts*, *thrust-bearings*, *motor-hooks* and *yokes*, *S-hooks*, *cans* and *wing-clips* require music wire, sizes Nos. 8 to 14. Use Nos. 8 and 10 for small and medium-sized models, and Nos. 10, 12, and 14 for large models. For shaping the wire you must have a pair of round-nosed pliers. With practice, you will get the knack of handling the pliers

so that you can bend the wire into tiny round eyes and nicely shaped loops and hooks.

**A Propeller-shaft** should be shaped like detail *a* of Fig. 402, with one end hooked, the other end straight. In mounting the propeller, stick the straight end of the shaft through the hub, bend it over, coat it with cement, and draw the point back into the hub.

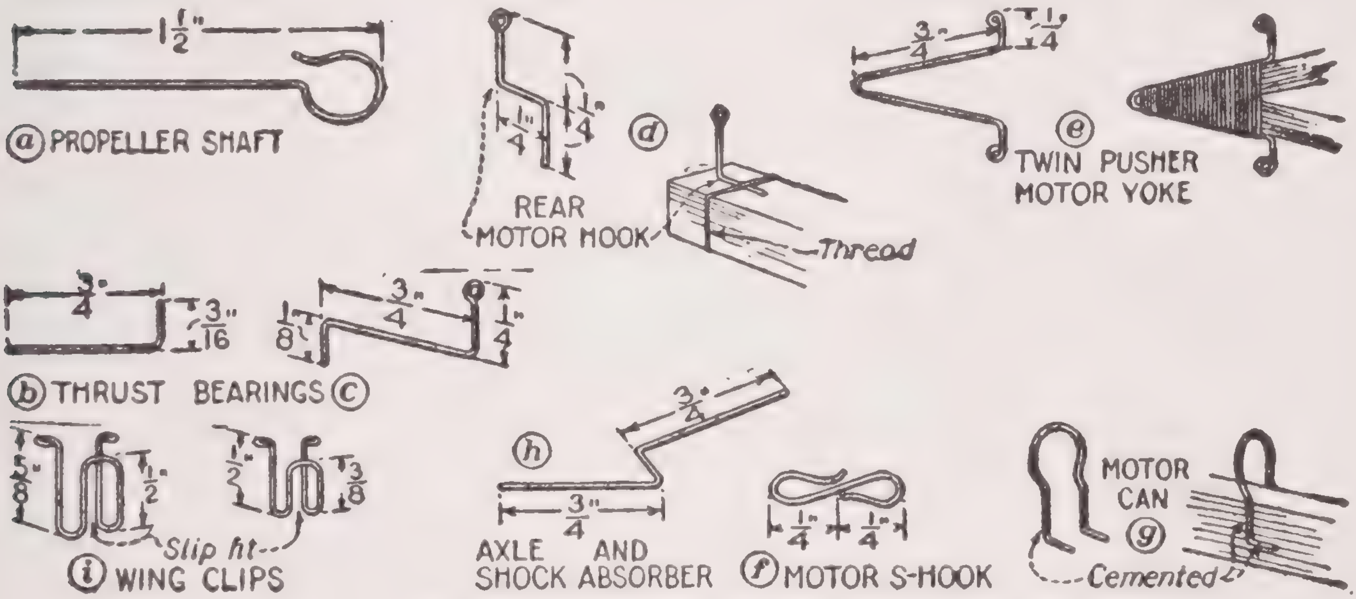



FIG. 402. — Wire Fittings.

**Thrust-washers** to fit over the propeller-shaft, between the propeller hub and the thrust-bearing, should be of thin brass. You can punch them with a paper-punch, then pierce the centers with the point of a phonograph needle. But you will probably prefer to buy them. They are inexpensive.

**A Thrust-bearing** is necessary to support the propeller-shaft of stick models. Detail *b* of Fig. 402 shows a bearing made of a needle. Select a needle with an eye that is almost round. Remove the temper by

heating the needle to a red heat, then allowing it to cool slowly. Bend the needle, cut off the required length, and harden it again by heating, then plunging it into cold water. Shaping a wire bearing like that in detail *c* is not difficult when you have learned the trick of forming small round eyes in wire with your pliers. The bend in the end opposite the eye is provided for anchorage in the motor base. Coat it with cement, then push it into the wood. Bind with thread, as shown in the detail of a motor-hook.

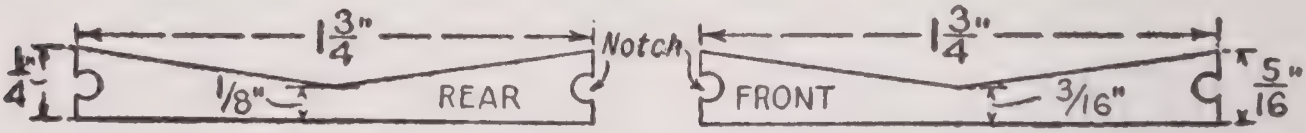



FIG. 403. — Wing Incidence Blocks.

**A Rear Motor-hook** is shaped like the wire thrust-bearing, except that the eye is turned to the side. See detail *d* of Fig. 402.

**A Motor-yoke** for a twin-pusher stick model is shown in detail *e*. Be careful to get the pair of hooks alike. Attach it to the frame, as shown, with cement and a whipping of linen thread.

**A Motor S-hook** should have long, narrow hooks, with the ends almost closed, as shown in detail *f*.

**A Motor Can** is a wire loop support for the unwound rubber of a motor. Detail *g* shows a can before and after cementing to the motor-base. The size of the can will be determined by the size of motor-base stick and the number of rubber strands used in the motor.

**Axles and Shock-absorbers** can be shaped in one piece, as shown in detail *h*. Cement the upper end to the running-gear strut. Slip a bit of motor rubber over the axle end to keep the wheel in place.

**Wing Clips** (Fig. 402 *i*) are used on stick models for mounting the wing and sometimes the stabilizer. The small loops are formed for cementing to the wing spar, the large loops are spaced at the right distance apart

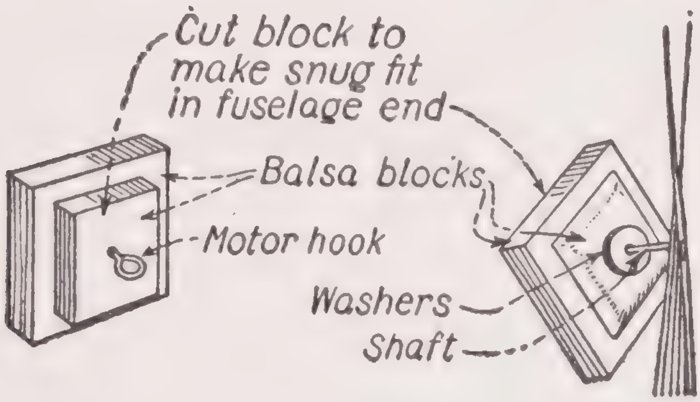



FIG. 404b. Tail Block.

FIG. 404a. Nose Block.

to make slip fits over the motor-base stick, and they are made of the right length for adjustment up and down to give the wing the required angle of incidence.

**Incidence Blocks** are generally used instead of wing clips for mounting a wing upon a fuselage model. They are cut out of balsa. The dimensions will vary with the model. Figure 408 shows a pair adapted to the IF-32 Indoor Duration Model described and illustrated in Chapter XXXI. The blocks are cemented to the spars. Then the wing is attached with a rubber band passed over the wing tips and under the fuselage,

as is clearly shown in the photograph in the frontispiece of this book, or a rubber band is passed under the fuselage, and its ends hooked over the ends of the incidence blocks. The ends of the incidence blocks in detail 403 are notched for this purpose. It is better to use the latter method, because it is difficult to loop bands over the wing tips, and slide them along to the center, without breaking the delicate frames. Wing-band rubber should not be more than $\frac{1}{32}$ inch thick. Rubber strands from a golf ball are of the right size.

A thrust-bearing is not needed for a fuselage model as the propeller-shaft can be run through the center of

**The Nose Block,** as shown in Fig. 404a, a detail of the nose block used for the IF-32 model described in Chapter XXXI. This nose block is built up of three balsa blocks, the inner one of which is cut of the right size to make a snug fit in the end of the fuselage. For a scale model, you will, of course, shape the nose block to the form of the ship's cowling.

The rear motor-hook of a fuselage model is commonly attached to

**A Tail Block.** This is generally made of two pieces of balsa, cemented together. The inner block is cut to make a snug fit in the fuselage end. The tail block is made removable to provide accessibility to the rubber-strand motor.

## Definitions of some Aeronautical Terms.

The following are not presented as a complete vocabulary, but to explain many of the terms with which model builders should be familiar. With how many are you acquainted?

**Aileron.** A movable horizontal auxiliary surface of an airplane, used to roll, or to maintain balance. Usually, a hinged portion of the trailing edge of a wing.

**Airfoil.** A flat or curved wing-like part of an airplane, whose function it is to obtain surface reaction from the air that it passes through.

**Angle of Attack.** The angle formed by the chord of a wing surface and a line parallel to the direction of motion.

**Angle, Dihedral.** Generally accepted as the acute angle formed by a supporting surface and the horizontal plane, as indicated in the front elevation diagram of a biplane; but often defined as the obtuse angle formed between two supporting planes.

**Angle, Gliding.** The angle made to the horizontal by the path in flight of a glider, or an airplane with engine shut off. An airplane having a gliding angle of 1 to 5 can glide, in still air, from an altitude of 2,000 feet, a distance of 10,000 feet.

**Angle of Incidence.** The acute angle between the chord of the wing surface and the propeller axis.

**Aspect Ratio.** The ratio that the spread of the length of a supporting surface bears to its depth or chord.

**Bank.** To incline an airplane laterally. In making a right bank, the plane is tipped to the right.

**Body.** The fuselage.

**Cabane.** A wing support at the fuselage.

**Camber.** The rise, from its chord, in the curve of an airfoil.

**Chord.** A straight line joining the leading-edge and and trailing-edge of a wing or other airfoil.

**Cockpit.** An open cabin in the fuselage with seat for pilot or passengers.

**Control, Lateral.** Ailerons and their operating parts.

**Control, Longitudinal.** Elevators and their operating parts.

**Controls.** Parts by which the pilot controls the speed and direction of flight of an airplane.

**Dive.** A steep descent with or without power.

**Dope.** A light-weight waterproof liquid, colorless or colored, used for filling airplane fabric to make it air-tight, waterproof, and taut.

**Drift Wires.** Wires provided to prevent wings from folding back.

**Duration or Endurance.** The maximum time that an aircraft remains in the air in a flight.

**Elevator.** A horizontal surface or surfaces, usually hinged to stabilizer, by means of which an airplane is steered upward or downward.

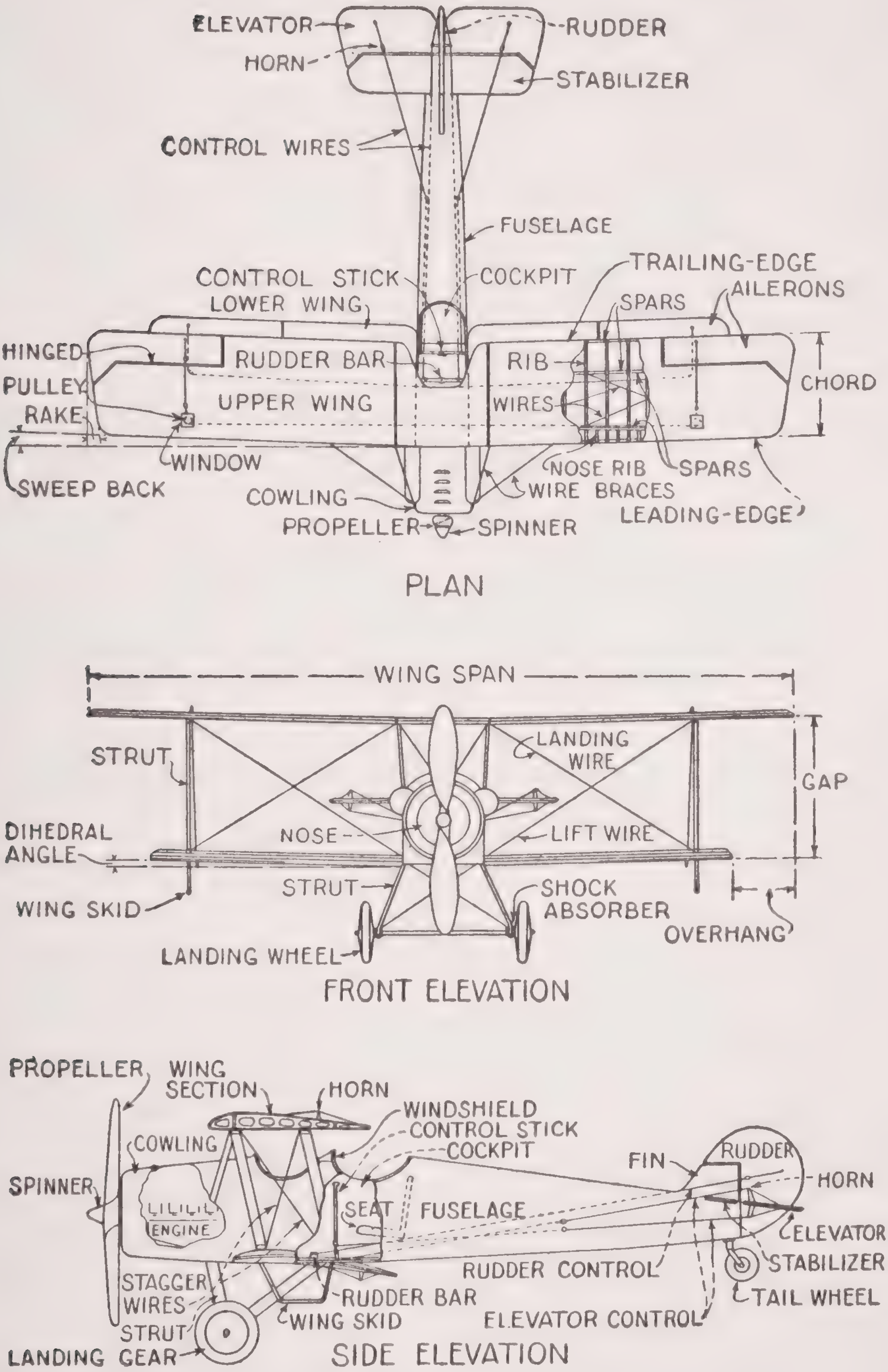
**Empennage.** Tail surfaces of an airplane.

**Entering-Edge.** Same as Leading-edge.

**Fabric.** Generally Irish linen or mercerized cotton, and known as airplane cloth. It is filled, shrunk and finished with about four coats of airplane dope and two coats of varnish.

**Fin.** A vertical fixed surface in the tail of an airplane used as a rudder, and to give directional stability.

**Float.** A water-tight compartment attached to an airplane, to provide buoyancy in case a landing is made upon water.




Structural Parts of an Airplane.

**Former.** A member of a cross frame fitted between the longerons of the fuselage.

**Fuselage.** The body of an airplane, housing the motor, cockpits or cabins, and equipment, and supporting the wings, tail, and landing gear.

**Gap.** The vertical distance between the chords of the wings of a biplane.

**Glider.** An airplane without power plant.

**Hangar.** A shelter for aircraft.

**Horn.** A short lever on a surface, to which control wire is attached.

**Landing Gear.** The substructure which supports an airplane when landing.

**Leading-Edge.** The front edge of a wing or other airfoil, or a propeller. Also known as the "entering-edge."

**Longeron.** An horizontal member of the fuselage framework.

**Nacelle.** An enclosure for passengers, or for a power plant.

**Pancake.** To descend steeply with wings at a large angle of attack.

**Pitch of a Propeller.** The distance forward that a propeller would travel in one revolution, if it turned as a bolt turns in a nut, without slip.

**Pusher.** An airplane with a propeller or propellers in the rear of the wing or wings.

**Ribs.** The cross-members of a wing, or other airfoil framework, of the correct shape to produce the required cross-section.

**Rudder.** A vertical airfoil used for steering.

**Rudder Bar.** The foot bar to which rudder control wires are attached.


*Courtesy of "The Chicago Daily News."*

Junior Aëronautics.

Inspired by the First Flight of the Wright Brothers.

**Skid.** The rear landing point of an airplane, attached to the under side of the tail.

**Skidding.** Sliding sideways in flight, usually as a result of insufficient banking at a turn.

**Slip.** Loss, a result of the give of the air. The difference between the actual and theoretical distance traveled by propeller in one revolution.

**Span.** The distance from tip to tip of a wing or other horizontal airfoil.

**Spar.** The horizontal members of the wing framework.

**Stabilizer.** A fixed airfoil provided to lessen the pitching motion of an airplane.

**Stagger.** The distance that the leading-edge of the upper wing projects over the leading-edge of the lower wing.

**Stall.** A stand-still condition, when an airplane has lost the air speed necessary for support.

**Strut.** An upright between planes, and one of the uprights or diagonal members of a landing gear.

**Sweepback.** The angle in a wing when its horizontal center-line breaks at the center, and slants back. Also, sometimes formed on the trailing-edge of a propeller, by cutting away the blades, so as to make them slant in from the tips to the hub.

**Tail, or Empennage.** The rear end of a plane, including the stabilizer, elevator, rudder, and fin.

**Tail Wheel.** A landing wheel attached to the under side of the tail, in place of a skid.

**Taxi.** To run over the ground, before taking off and after landing.

**Torque.** A twist, or tendency to twist, produced by the revolving propeller.

**Tractor.** An airplane with a propeller or propellers in front of the wing or wings.

**Trailing-Edge.** The after edge of a wing, or other airfoil, or a propeller.

**Warp.** To change the form of a wing by twisting it.

**Wash-In.** An increase in the angle of incidence of a wing at or near the tip.

**Wing.** A main supporting airfoil of an airplane.

**Zoom.** To climb at a steep angle, to gain altitude rapidly.

The rules that have been used successfully in national tournaments are recommended for local contests. Through the courtesy of the Playground and Recreation Association of America, the following is quoted from the

## RULES AND REGULATIONS
### FOR THE
## NATIONAL PLAYGROUND MINIATURE AIRCRAFT TOURNAMENT

Each community from which competitors may desire to enter the National Tournament must have a committee to administer the local competitions and to certify to the local records. This committee should include the superintendent or director of the playgrounds of the city, or, where the playgrounds are administered under more than a single auspices, the superintendent or director of each system; the president or one of the vice presidents of the Chamber of Commerce or similar organization; editors of local newspapers; a member of the Board of Education, or superintendent of schools; the president or vice president of the local aeronautic society or similar official of a local flying field or airport. Others locally desirable may, of course, be added.

The National Committee will furnish official blanks to local committees upon which records, qualifications of contestants, and other facts are to be reported. The facts called for must be authoritatively certified by the committee responsible for the local tournament before contestants are qualified to compete in the national tournament. Information as to methods of registering competitors, trial flights, previous inspection of planes, methods of running off and judging the events, may be secured from the Playground and Recreation Association of America, 315 Fourth Avenue, New York City.

Boys and girls up to, but not including twenty-one years of age, are eligible to compete in the tournament. There are two classes:

1. Junior—those who have not yet attained the sixteenth birthday.
2. Senior—those who are past the sixteenth birthday and who have not yet attained the twenty-first birthday.

## EVENTS

There will be 7 events, 3 indoor and 4 outdoor, for each class (Junior and Senior). (Number of events varies from year to year.)

Committees arranging local tournaments are urged to include all events listed in the national tournament. Of course, other events may be added locally, but local champions will have a much better chance for success in the national tournament, if they have had practice in their local tournaments in events scheduled for the national tournament.

A complete list of events will be found in Chapter VI of "Big Book of Boys' Hobbies."

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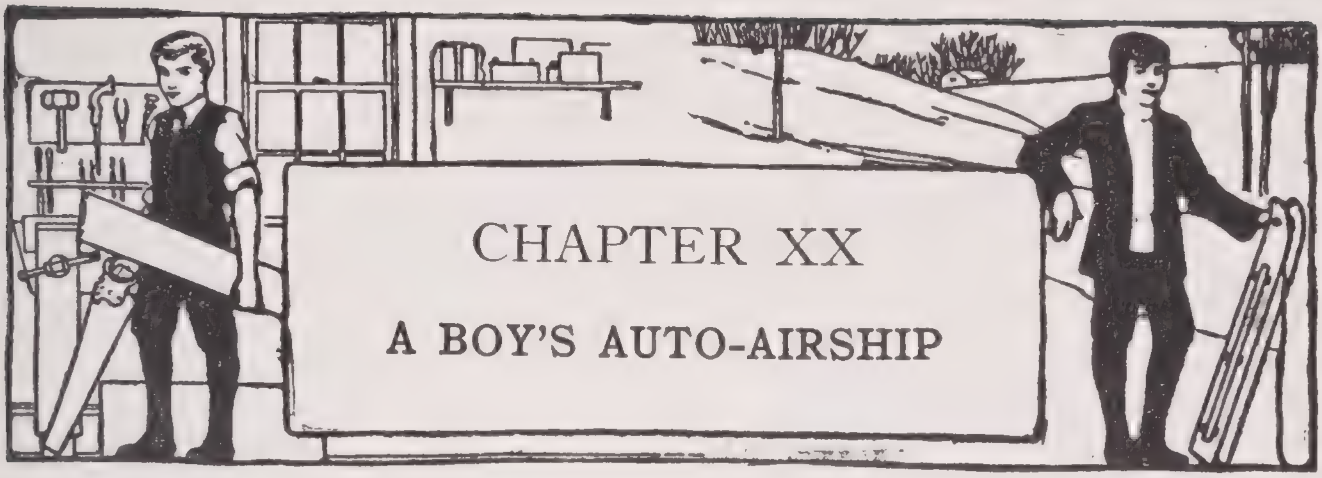


# CHAPTER XX

## A BOY'S AUTO-AIRSHIP

It has always been instinctive for a boy to want to get his feet off the ground—climbing, jumping, swinging, building tree huts, and, finally, flying. But since piloting a plane is not to be classed as a boy's hobby, and since such stunts as are pictured in Mr. Bradley's cartoon upon page 326 are practical only as flights of the imagination, it is up to you to devise your own means of air travel.

The author's ambition in this direction led him from flying-rings to a home-made aerial scooter. This consisted of a seat suspended from a tackle block that ran along a rope cable. The upper end of the cable was hitched to the rafters over the barn loft. The lower end was fastened to the house several feet above the basement windows. Flight started from the loft. We "flew" out through the barn window, "nosed-down" across the yard, and made a two-point landing with feet thrust against bed-springs placed against the house for shock absorbers.

The good features of this home-made airship have been used in plans in this chapter, and they combine


FIG. 405. — The Auto-airship in Flight.

safety with many of the thrills of flying. As you will see by looking at Figs. 405 and 406, the rope cable along which the airship flies is hung low enough to keep the

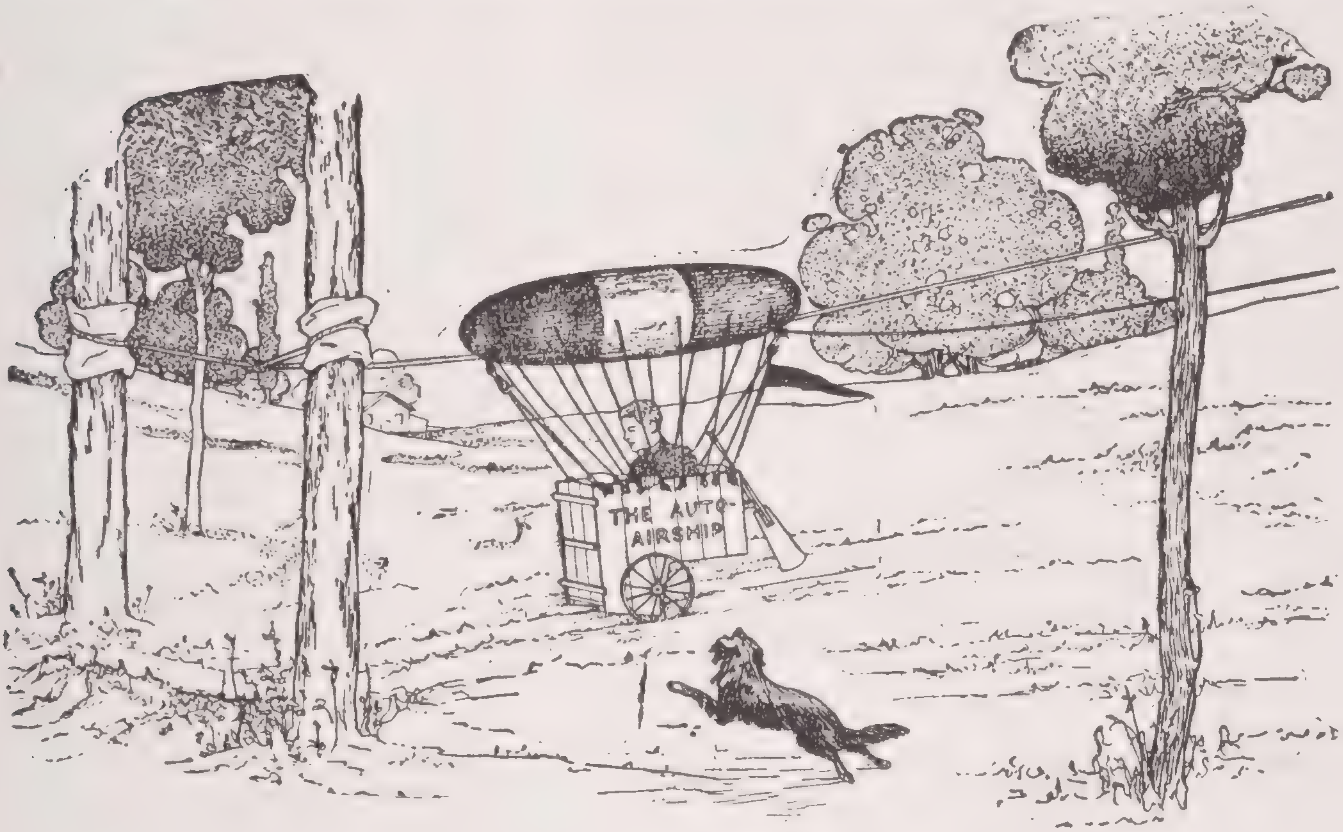



FIG. 406. — Making a Landing.

course of the young aviator always close to the surface of good old Mother Earth.

**For the Framework of the Balloon** (Fig. 407), procure eight barrel hoops and three 1-by-2-inch strips 12 or 14 feet long, and purchase at a hardware store two wooden *single blocks* (the size for $\frac{3}{4}$-inch rope, with *hooks* and *beckets*, Fig. 411), 3 pounds of No. 12 steel wire, and $\frac{1}{2}$ pound of small copper staples (Fig. 408).

From the 1-by-2-inch strips cut *A*, *B*, *C*, and *D* 5 feet 8 inches long, and crosspieces *E*, *F*, *G*, *H*, *I*, and *J* of the lengths shown in the top view of the framework (Fig.

409). Remove the beckets from the single blocks, unscrewing the bolts which hold them in the iron straps (Fig. 411), and bore a hole, the size of those in the straps, through strips *C* and *D*, $1\frac{1}{2}$ inches from each end. Then

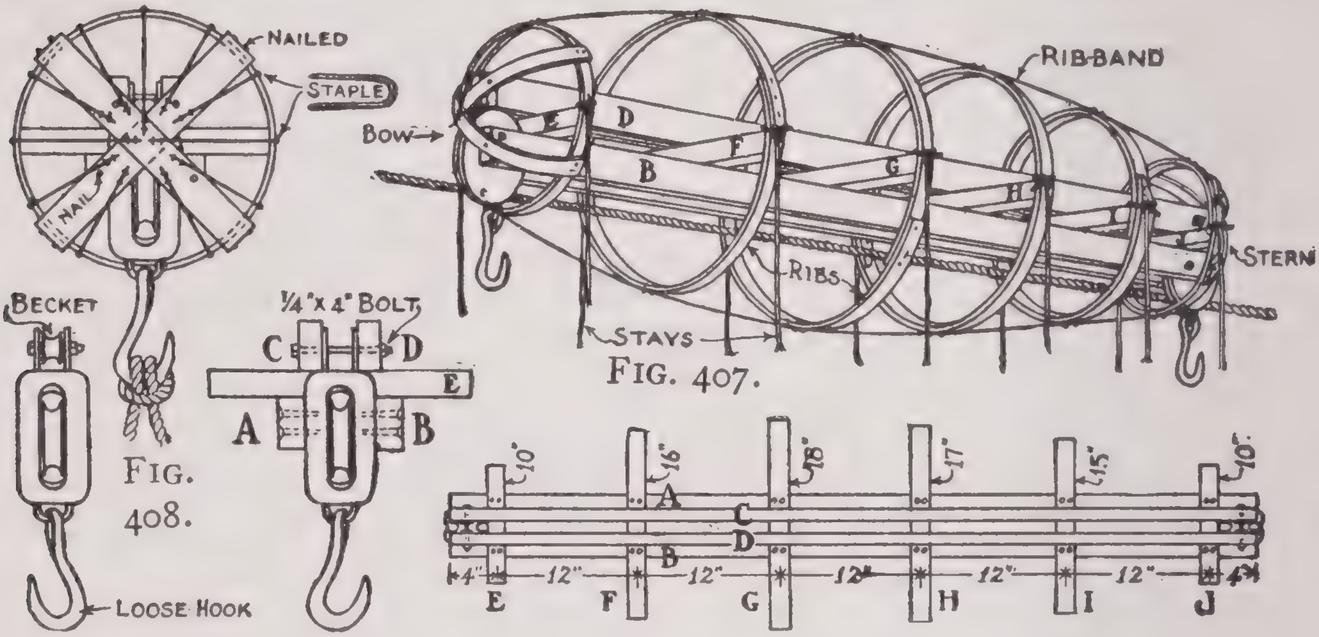



FIG. 408.

FIG. 407.

FIG. 411. FIG. 410. FIG. 409.

FIGS. 407 and 408. — Side and End Views of Framework of Balloon.

FIGS. 409 and 410. — Top and End Views showing Framework before Ribs and Rib-bands are attached.

FIG. 411. — Wooden Single Block.

bolt *C* and *D* to the becket straps (Figs. 409 and 410), using 4-inch bolts. Nail the crosspieces to *C* and *D*, spacing them as shown in Fig. 409; then nail strips *A* and *B* to the crosspieces, and screw their ends to the wooden shells of the blocks (Fig. 410). Two nails should be used at each point of nailing, to insure a strong framework.

**The Barrel Hoop Ribs** are fastened to the ends of the crosspieces (Fig. 407). Remove the nails which hold the hoops together, and turn in the ends until the inside

diameters equal the length of the crosspieces, then drive several nails through the ends and clinch them on the inner side of the hoops. To build out the bow and stern of the framework (Fig. 407), cut the two remaining hoops in halves, cross a pair of these halves at right angles for each end, and fasten their centers together; then nail the ends to the end ribs and drive in a nail at the points where the hoops cross strips *A*, *B*, *C*, and *D* (Fig. 408). Clinch all nails wherever it is possible to do so.

**Cut Twelve Rib-bands** from the No. 12 wire, fasten one across the bottoms of the ribs, another across the tops (Fig. 407), and space the remaining ten between them at equal distances. The intermediate rib-bands are shown in Fig. 408, but have been omitted in Fig. 407 to make that illustration clearer. Fasten the rib-bands to the ribs with staples (Fig. 408).

Before inclosing the framework, cut twelve 6-foot lengths of heavy cord for

**Stays**, and tie one to each rib just above the crosspiece (Fig. 407); also run a cord through the blocks, so that when you are ready to slip the balloon on to its rope cable, you can tie the end of the cord to the rope and, by means of it, pull the rope through the wheels of the blocks.

You will require $4\frac{1}{2}$ yards of cloth for

**The Balloon Envelope.** A black, brown, or gray cambric or muslin will make the most durable covering, but any cloth you can get, such as old sheets, can be used.

Put the cloth on lengthwise of the framework in two strips, stretch it as smooth as possible, and fasten it to the ribs with tacks and to the rib-bands with thread. On top of the envelope sew a band of white cloth around the center of the balloon (Fig. 405).

**The Construction of the Car** requires but little explanation, as Figs. 412 to 418 show the details clearly. Pro-

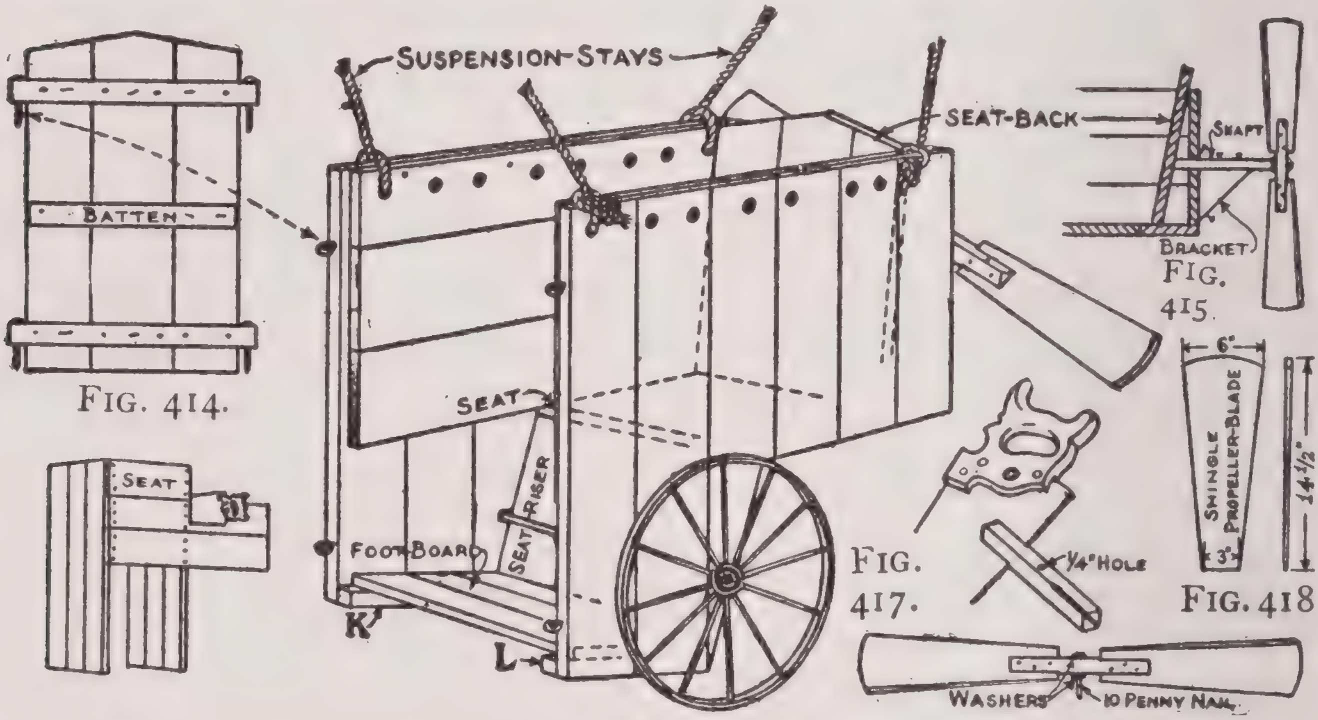



FIG. 414. FIG. 415. FIG. 417. FIG. 418.

FIG. 413. FIG. 412. FIG. 416.

FIG. 412. — The Car.
FIG. 413. — First Step in making over a Box for a Car.
FIG. 414. — Gate for Front of Car.
FIGS. 415 to 418. — Details of Propeller.

cure a box about 16 inches deep, 20 inches wide, and 3 feet long; remove the bottom and one end, nail the bottom boards crosswise to form the car seat (Fig. 413), and saw off the projecting ends. Reënforce the sides of the box with vertical boards (Fig. 412). Cut the first two boards long enough to support the pitched foot-

board, which should be fastened 14 inches below the seat, and make the first board on each side project 1 inch beyond the box (Fig. 412) to form a rabbet for the gate to set in. Nail cleats *K* and *L* to the side boards, where shown, and fasten the foot-board upon them. Fit the seat-riser between the seat and foot-board, make a seat back as shown in Figs. 412 and 415, and attach a pair of wagon wheels to the sides.

Fasten the gate boards together with three battens, making the top and bottom battens long enough to project $1\frac{1}{2}$ inches on each side; drive a 20-penny (4-inch) nail through each end of the projecting battens, and screw four screw-eyes into the front of the car for sockets, in which to set them (Figs. 412 and 414).

Bore eight $\frac{5}{8}$-inch holes through each side of the car, $1\frac{1}{2}$ inches below the top, through which to tie the stays (Fig. 412); then cut two 6-foot lengths of $\frac{1}{2}$-inch rope for the suspension stays, and tie the ends of one through the two front holes, and the ends of the other through the two rear holes (Fig. 412).

**The Propeller** (Figs. 415 to 418) requires a hub strip 1-by-1-by-10 inches in size, with a $3\frac{1}{2}$-inch slot in each end (Fig. 417), and two blades similar to Fig. 418. Notice that the slots are cut diagonally across the ends of the hub strip, and that one is at right angles to the other. Bore a $\frac{1}{4}$-inch hole through the center of one side of the hub strip (Fig. 417), then fasten the blades in the slots. Cut a stick 11 inches long for the propeller

shaft (Fig. 415), fasten the propeller to one end, and insert the other end in a hole bored through the back of the car; nail it securely in position, and brace it with a wooden bracket.

If you stretch the cable for your airship upon a hill-side, you will require

**A Starting Platform** just high enough to lift the car off the ground, but if the ground is level, or nearly so (Fig. 405), it will be necessary to construct a platform 8 feet or so above the surface to give the rope cable sufficient pitch.

This platform is built between two trees, 3 or 4 feet apart, and is supported by four brackets. Each bracket consists of three pieces of 2-by-4, as you will see by looking at Fig. 405. Cut the piece marked *M* 4 feet long, and *N* and *O* 2 feet 6 inches long; miter the lower ends of *N* and *O*, and let their upper ends into *M*. Nail the pieces together and spike two brackets to each tree; then spike crosspieces *P* and *Q* across the trees, directly under top piece *M* of the brackets, as additional supports. Cut the railing uprights *R*, *S*, and *T* 5 feet long, mortise the upper ends for the gate (*U*) to slide through, and spike them to the brackets. Brace the lower ends with the diagonal pieces *V* and *W*, and their upper ends with boards *X* and *Y*. Cut the gate (*U*) long enough to reach from *R* to *T*, insert a short stick in a hole bored near one end, for a handle, and nail a strip across the other end to prevent it from pulling

through the mortise in upright *R*. Nail the platform boards in place, and fasten

**A Push-off Platform** (*Z*) between the trees, 18 inches above the main platform, for the car.

Build a ladder from the ground to the main platform.

**The Rope Cable.** Purchase $\frac{3}{4}$-inch Manila rope for the cable, and get whatever length you will require in one piece. Fasten one end of this rope to a tree a few feet in back of the upper station platform (Fig. 405), then run it through the single blocks in the balloon framework, and while you pull on the rope to take up as much of the slack as possible, have some one tie the lower end to the center of a rope stretched between two trees at the lower end of the airship's course (Fig. 406). If there doesn't happen to be a tree directly in back of the upper station, you can attach that end of the rope between two trees, in the same way that you fastened the lower end. Tie the lower end of the rope low enough so the car will run upon the ground for a few feet, and slow up, before reaching the end. Throw some loose earth over the point of landing, and from there as far as the end of the rope, to retard the speed of the wheels.

**To attach the Car**, hitch the loops of the suspension stays over the block hooks (Fig. 405), and tie the ends of the intermediate stays through the holes in the sides of the car.

**To pull back the Airship to the Starting Platform,**

attach a strong cord to the hook in the stern block, run it through a small pulley attached to the upper end of the cable (Fig. 405), and bring it down below the platform to a windlass constructed as shown in the illustration.

**If several of you boys club together** in building an auto-airship, you will have to "toss up" to see who shall have the first ride; then, after all of the "directors" and workmen have ridden, you will want your friends to enjoy a trip. By charging a small fare you can make the airship pay back, in a short time, what you have expended for material.

# CHAPTER XXI

## CAMPING EQUIPMENT

When the last day of school arrives, isn't it with a sense of relief that you pack up your books, carry them home, and throw them on to a high shelf, or into your bedroom closet — somewhere out of sight? And isn't it hard to realize that you need not think of lessons again for more than two months, and that you are free to do whatever you choose for the balance of the summer days? It used to be that way when the author was a boy, and conditions probably haven't changed much in this regard.

Some of you boys will experience the joys of camping out for the first time this summer, — the trip which always remains freshest in one's memory, as it generally is so full of amusing incidents, — and those of you who have camped out before will probably not miss an opportunity to do so again this year; but, if it is not possible for you to go away from town, there is no reason why you cannot camp out near home, in some vacant lot, or in your back yard, or on the porch or roof.

**A Tent** is one of the first parts of the camping equipment to look after. The prices of tents vary in different

locations, but you can get an 8 foot by 10 foot "A" tent (Fig. 419) of 10-ounce duck, complete with poles and stakes, in New York, Chicago, Denver, or San Francisco, for about $7, and a wall tent of the same size (see photo-

FIG. 419. — An "A" Tent.

graph opposite page 340) for about $9, while a *fly* will cost about one half as much as the tent.

If you wish to make a tent yourself, you will not find the work difficult, and you will save considerable on the cost. The sewing together of the strips of canvas is the hardest part of the work for a boy; probably your mother will be willing to do this for you on her sewing-machine. Eight-ounce duck, 29 inches wide, retails at about 15 cents a yard, and the 10-ounce weight, which is better for the purpose, at about 18 cents a yard.

**For making an "A" Tent** of the size shown upon the diagram (Fig. 420), you will require 30 yards of material. The diagram shows the completed tent as it would appear

when spread out flat upon the ground, and also the dimensions for cutting the different lengths of canvas. You will see that strips *A*, *B*, *C*, and *D* are of equal length, and that strips *E*, *G*, *J*, and *K* are of one shape and size, as are also the triangular pieces *F*, *H*, *I*, and *L* and strips *M* and *N*. Lap each strip a full 1 inch over the edge of the adjoining pieces, as indicated by the dotted lines on the diagram, and sew each seam near the edges with a double row of stitching. After all of the pieces have been cut and sewed together, turn back the outside edges 1 inch, as indicated by dotted lines, to finish them off and at the same time, reënforce them.

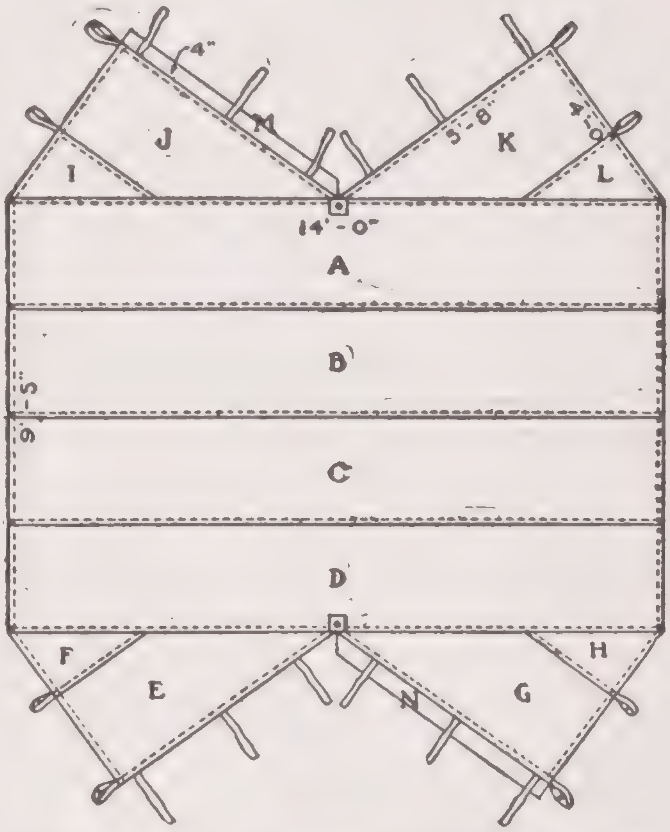



FIG. 420. — Diagram for Making an "A" Tent, 7 feet by 9 feet and 5 inches.

Buy one dozen 1-inch iron harness rings for the ridge and guy-rope eyelets, set two in the canvas at the ends of the ridge, and one at the end of each of the side seams, and buttonhole stitch them in place. The canvas should be reënforced with a square patch in the places where the eyelets are to be set in in the ridge. Sew canvas loops and straps to the flaps, in the locations indicated, and tie the guy-ropes through the eyelets provided for them.

Figures 421 to 423 show the details for

**The Ridge-pole and Uprights**. These should be cut out of pieces $1\frac{3}{4}$ inches square, which may be ripped out of a piece of 2-by-4. Cut the uprights about 5 feet 10 inches long, which will allow for setting the ends 3 inches into the ground, and the ridge-pole 9 feet 5 inches long. Round off the top of the ridge-pole as in Fig. 423. Drive a piece of $\frac{3}{8}$-inch or $\frac{1}{2}$-inch iron rod into one end of each upright (Fig. 422), and bore two holes, $\frac{1}{8}$ inch larger than the rods, through the ridge-pole in the proper positions for the rods to fit in (Fig. 421). A piece of tin bent around the ends of the pole, as in Fig. 423, will prevent the rods from splitting them.

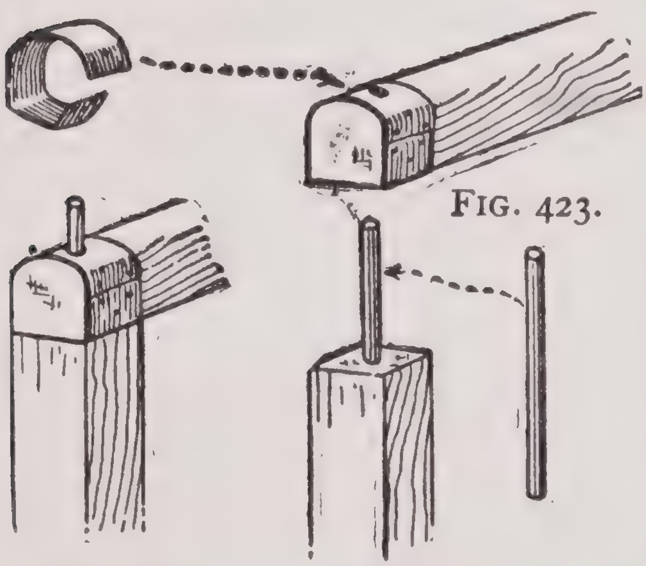


FIG. 423.

FIG. 421. FIG. 422.

FIG. 421. — Connection of Ridge-pole with Upright.
FIG. 422. — End of Upright.
FIG. 423. — End of Ridge-pole.

**Fourteen Tent Stakes** will be required, and these should be prepared at home, to save delay in pitching the tent after you reach your camping ground.

**Pitch your Tent** upon a level spot, close to your water supply if possible, and dig a little trench around it to catch the surface rain-water, which would otherwise run into the tent; make a couple of outlets from the trench, on the low side, so the water will drain away. Do this

A Wall Tent, Eight Feet by Ten Feet, with Fly.

Flapjacks for Two.

trenching as soon as you have pitched your tent; otherwise, you may be caught unprepared for a storm, and it is unpleasant to be compelled to do the work during a drenching rain.

**A Tent Ground-cloth**, which should be of waterproof material, should be laid upon the ground and lapped up around the sides of the tent; this will prevent the dampness of the ground from penetrating your bedding.

If there are spruce or pine trees in the vicinity of your camp, be sure

**To make a Mattress** upon which to spread your blankets. Cut a number of boughs, and lop off enough of the tips of the branches to form a good-sized pile of twigs. Then carry these to your tent and, beginning at the proper point for the head of your bed, place a row of the twigs upon the ground-cloth with the tips toward the back of the tent. Next, place another layer of the twigs over these, and lap the tips over the butt ends of the first row, and continue to lay row after row in this manner, which is just the way in which the shingles on a roof are lapped, until you have reached the foot of the bed. The degree of softness of this mattress will depend entirely upon the care with which the twigs are placed and how well the butt ends are concealed by the tips. To avoid hard lumps, use only the slender portions of the branches. Spread your blanket upon the mattress, and your bed will be complete.

If the nights are cold in the region in which you intend to camp, take along

**A Sleeping-bag.** By folding over your blanket along the center, lengthwise, and then sewing it along the side and across the bottom, a very satisfactory bag may be made. The author has found such a bag very comfortable, and, when camping in the mountains where the temperature at night drops below "freezing," has used two of these bags, slipping one inside of the other, to give double warmth. With the top of the bag pulled snugly around your neck, there is no possibility for the cold air to reach you. The bag can be turned inside out every morning and aired. With covers in common, you are likely to awaken some night, feeling cold, to find that one of the other boys has been over-generous to himself with the clothes, unless you know how to "cling" to your portion; but with a sleeping-bag you are safe from disturbance.

**Other Equipment.** No two boys will carry the same equipment with them when going camping, and every boy will find after he has reached camp that he has taken along lots of needless things and left behind many articles which would add greatly to his comforts; but this is something which most campers experience, and it is doubtful if ever a man carries exactly the same outfit on two trips, for the reason that he is continually finding some way wherein he can make it more compact and complete. The greatest trouble lies generally in taking along too much. The

location of your camp will determine to a great extent what special articles should be included in the outfit, and an experienced camper, familiar with that part of the country, will be a good one to consult about your requirements.

A frying-pan, kettle, saucepan, baking pan, coffee-pot, wash-basin, two water pails, tin plates and cups, spoons, knives and forks, and a can-opener will be required for the kitchen outfit; and towels, rags, soap, rope and twine, matches, a lantern and a can of kerosene oil, candles, an ax, a sharpening stone, hammer, saw and nails, will just about complete the general equipment. It is a good plan to take several sizes of nails, — 8-penny, 10-penny, 16-penny, and 20-penny, — for there will probably be things which you will wish to make while in camp.

**An Electric Flash Lamp** is a very handy article to have for locating things in and about the tent, when you do not care to bother with lighting your lantern.

**Packing**. Wrap your matches in paraffine paper, and then place them in a tin can to protect them from dampness; and put all the other small articles of your equipment in small bags provided with draw strings; salt and flour sacks may be fixed for the purpose. Pack the sacks, and all other things belonging to the general equipment which are not too bulky, in grocery boxes. When you get to camp, you will find the boxes handy for keeping things in, and those not required for this purpose will make good stools and will be good for setting things on.

**A Safety Match-box**, a strong jack-knife, and fishing-tackle should be made a part of the personal equipment of each boy of the camping party, and if each has

**A Duffle Box** (Fig. 424) in which to carry his outfit, he will save a general mix-up of things, possible loss of small articles, and resulting unpleasantness with the other fellow whom he may think is to blame.

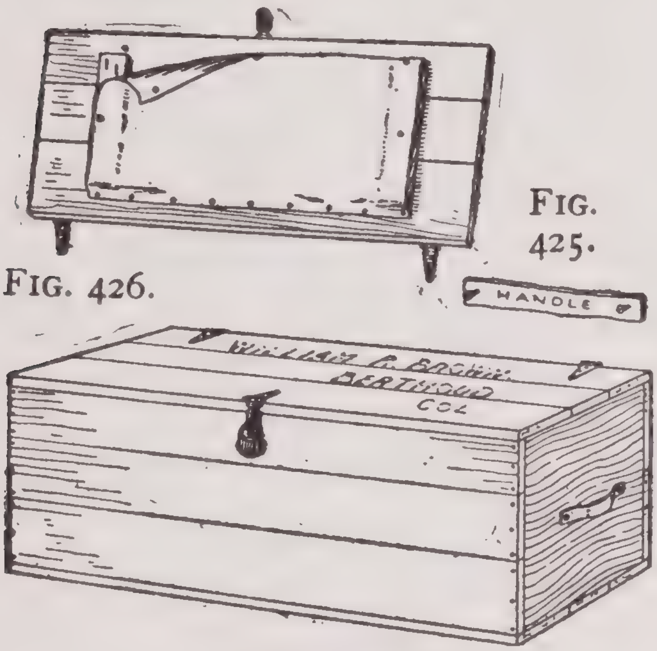



FIG. 426. FIG. 425. FIG. 424.

FIG. 424.—Camp Duffle Box.
FIG. 425.—Strap Handle.
FIG. 426.—Pocket on Inside of Cover.

A grocery box will serve the purpose, but this should be gone over carefully, and all boards whose nails show signs of loosening should have additional nails driven into them. Batten together the cover boards on the inside, hinge them to the box with strap-hinges, and fasten a hasp to the front so the box may be padlocked for transporting, and whenever you are away from camp. Handles may be made out of pieces of a strap, or several thicknesses of cloth tape, and be secured to the box with screws (Fig. 425). By fastening a piece of canvas or heavy cloth to the inside of the cover, over the battens (Fig. 426), tacking it along the bottom edge, and making buttonholes in the side and upper edges to button over large-head tacks, the space be-

tween the battens will serve as a pocket for writing materials.

If any boy in your party has had experience in camp cooking, leave to him the matter of purchasing

**Food Supplies.** But if you are all "green" at it, you had better get your mothers to help you make out your grocery list. Each mother will have a pretty fair idea of the size of her son's appetite, and it ought to be an easy matter for her to estimate on the proper quantities and varieties of supplies to do him. But she should be warned, beforehand, to allow for an increased appetite; also to select such things as can easily be prepared. Then compare all the lists and compile one complete list from them.

Fish and game may possibly be secured while in camp, but it is best not to count upon this as a certainty, and to take along plenty of everything, unless you know that your camp will be within easy reach of supplies.

**If you are to be Cook**, find out how to make flapjacks, graham muffins, biscuits, and johnny-cake, and watch your mother to see how she prepares breakfast cereals, coffee, and tea; also try your hand at cooking these things while at home, instead of waiting until you get into camp and starving your companions, as well as yourself, during the experimental period. It will save lots of unpleasantness all around.

The trouble met with in

**Making an Open Fire** for cooking generally arises from

getting it too large, so that it is all blaze and smoke. What is necessary is a small fire of hot coals. If you have watched an experienced camper prepare his fire, you have noticed that he confines it to a small place.

**The Backwoodsman's Scheme** of building his fire between two logs placed alongside of each other, about 6 inches apart at one end and 12 inches apart at the other end (Fig.

FIG. 427. — The Backwoodsman's Camp Fireplace.

427), is very satisfactory for a fireplace, as the fire is confined between the logs, and, by keeping the wide opening turned toward the wind, a splendid draft is obtained.

The logs should be green, and, to prevent the fire from getting under them, it is well to plaster mud against their inner faces. Two forked branches are driven into the ground, one at each end of the fireplace, and a horizontal pole, known as a *lug pole*, rests in the forks and supports the pothooks.

**The Pothooks** may be made from forked sticks cut to the proper length, with nails driven into them near the lower ends (Fig. 428), or out of pieces of heavy wire bent into hooks at one end and loops at the other end (Fig. 429), the loops being made large enough so they will slide back and forth on the lug pole. Both the stick and wire pothooks may be made short enough to accommodate the largest pot you have, and then lengthened to suit the small utensils by means of S-shaped extension hooks bent out of wire (Fig. 430). A piece of tin from an empty tin can may be tacked across the logs for the coffee-pot and for handleless utensils which are too small for the logs to support.

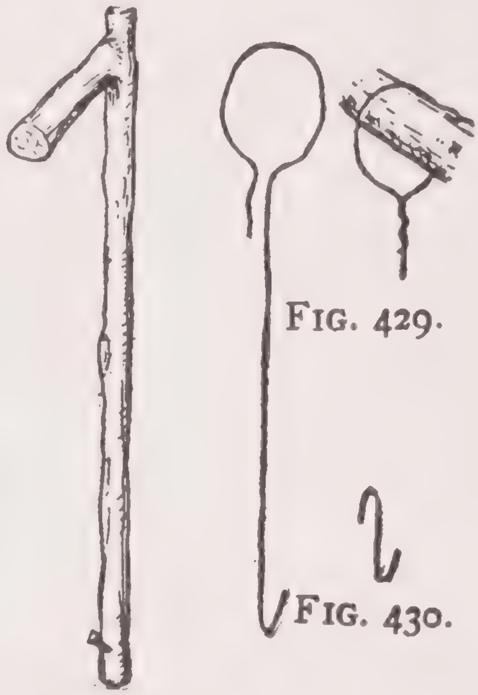


FIG. 429.

FIG. 430.

FIG. 428.

FIG. 428.—Stick Pothook.
FIG. 429.—Wire Pothook.
FIG. 430.—Extension Hook.

Such a fireplace as the above can be built anywhere, even in a back yard, with perfect safety, and any boy can use his ingenuity to rig up his pothooks and supports out of plain sticks if he cannot find suitable branches for the purpose.

**A Sheet-iron Camp Stove**, such as is shown in the photograph opposite page 340, is very commonly used by campers, and is handier and easier to cook on than the open fire. A stove of the size shown in the illustration can usually be bought complete with stovepipe for $1.50.

**A Dutch Oven** is a good substitute for the camp stove, and answers almost every purpose. It consists of a shallow iron pan or kettle, supported upon iron legs and furnished with a tight-fitting cover. It is set in a bed of red-hot coals, then after the biscuits, muffins, beans, meat, fish, or other food which is to be baked, stewed, or roasted is placed in the pan, the cover is fitted on and hot coals are heaped up at the sides and over the top. A medium-sized oven will cost $1.00.

**A Camp Fireless Cooker** is another handy contrivance, inasmuch as food can be prepared in it while you are away from camp, so that it will be ready to eat immediately upon your return at night tired and hungry. A cooker may be constructed out of a grocery box; and hay or dried leaves may be used for packing. Place this insulation under, around and over the boiling kettle. By setting the cooker box into a hole in the ground, and throwing earth over the cover after placing the food within, the insulation will be more nearly perfect.

**To build a Fire** properly, whittle a few shavings and cut a number of small sticks, — some to about the size of a lead-pencil and others a little larger, — spread the shavings along the bottom of the fireplace, and upon these pile up the sticks, loosely and crisscrossed, so as to allow plenty of openings for draft. Set fire to the shavings, and as soon as the sticks have kindled, add a few larger pieces of wood to the pile; but be careful not to put on too many pieces before the fire has made a good

start, or you will choke out the flame. A good fire is obtained only by careful building, and requires continual attention to be satisfactory for camp cooking.

Always keep a good supply of wood at hand, some place under cover where it will be protected from rain and dew, so you will never be without dry wood with which to kindle your fire.

**Camp Furniture.** A table and a few seats add to the comforts of camp life, and the making of these furnishes interesting occupation for days when you wish to stay around camp. The three tools mentioned among the camp equipment are all that are necessary for making camp furniture, because fine work is neither required nor desirable in the woods.

Figure 431 shows

**A Camp Chair** that is easily made. You will notice that the edges of all the pieces are left square, instead of being beveled to fit the adjoining surfaces, that the seat board *B* is nailed to the diagonal brace *C*, and the two fastened to the chair back *A*, with cleats *D* and *E* nailed on to support them, and that the diagonal leg *F* is slanted as much as you wish to have the chair back slant, and is braced by the two side braces *G*.

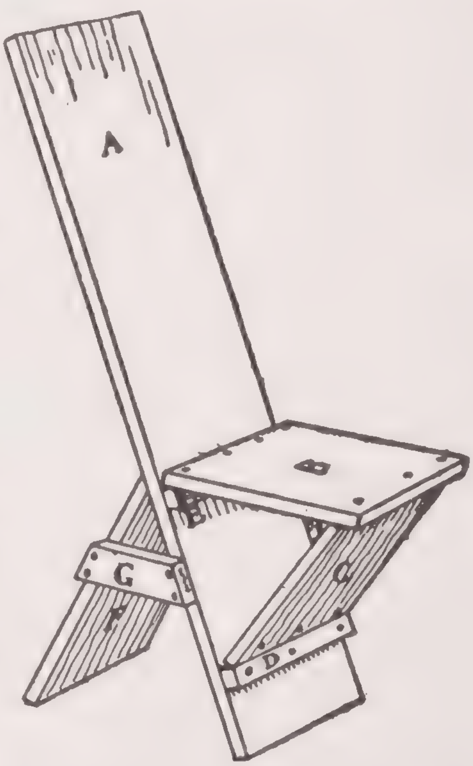


FIG. 431. — A Camp Chair.

**A Camp Table** (Fig. 432). By fastening together several

boards with battens, a good table top can be made, and this may be supported at one end on a cleat nailed across a tree trunk (Fig. 433), and at the other end on a couple of stakes driven into the ground (Fig. 432).

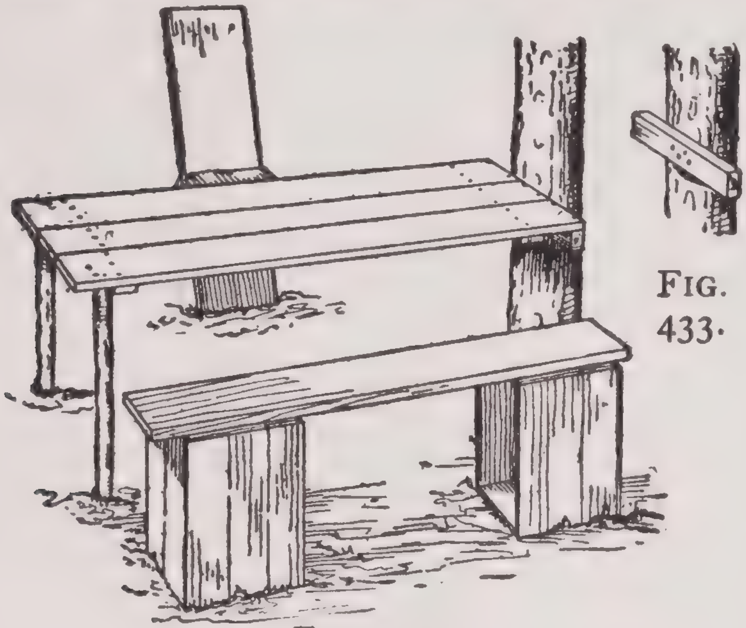


FIG. 433.

FIG. 432.

FIG. 432. — A Camp Table and Bench.
FIG. 433. — Cleat Support on Tree.

Boxes can usually be picked up in the vicinity of an old camp, and these, added to those in which you brought your outfit, can be utilized for many things.

**A Good Table Bench** is obtained by laying a plank across the tops of two boxes (Fig. 432), and

**A Comfortable Box Bench** is made by removing one side of a box, then placing the box on the ground, bottom up, and constructing a back as shown in Fig. 434. To keep it from overturning, nail the box to stakes driven into the ground. Use your ingenuity in constructing

**Box Cupboards** to hang in the tent and upon the trees.

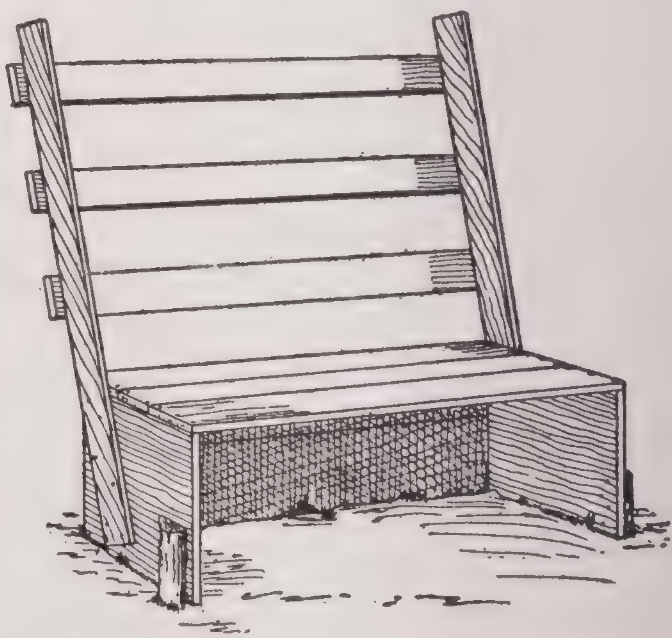


FIG. 434. — A Comfortable Box Bench.

# CHAPTER XXII

## A HOME-MADE PUNT

Good workmanship is necessary in boat building, not so much for the sake of appearance as for safety and durability, but neat appearance will not be found lacking in a properly planned and carefully built boat. The nearer a boat approaches the square lines of a box, the easier it is to build, and it is well for a boy to try one of the simplest forms, such as the punt shown in Fig. 435, for a first attempt. The principles of boat building are easily learned, and after you have constructed a punt you will have had enough experience to enable you to tackle other forms of craft of more complicated construction.

**Dimensions**. The punt shown in the illustration is 12 feet long, 3 feet 6 inches wide, and 18 inches deep, but these dimensions can easily be increased or reduced if you wish a boat of other proportions.

**Material.** Get pine or cypress for your building material, and be sure to see that it is well seasoned, dry, and free from knots and other defects. Stock 18 inches wide is generally hard to find, nowadays, in most localities, so probably you will have to use an 8-inch and a 10-inch

board, or a 6-inch and a 12-inch board, for each side. The bottom boards should be either 4 or 6 inches wide and

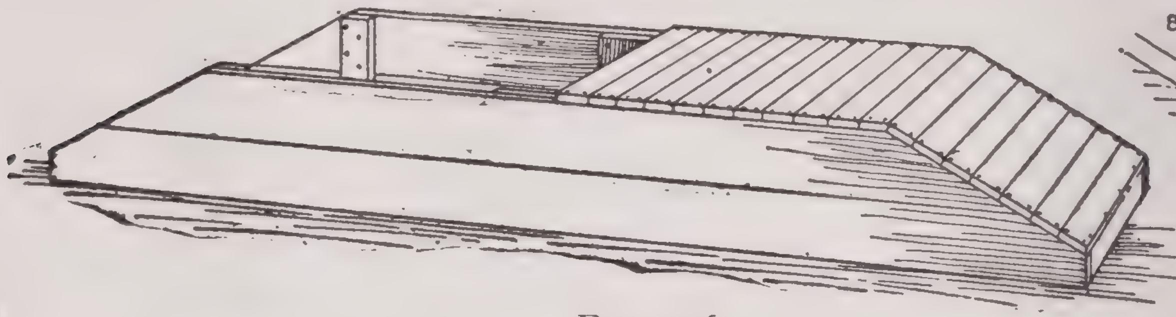



FIG. 437.

FIG. 436.

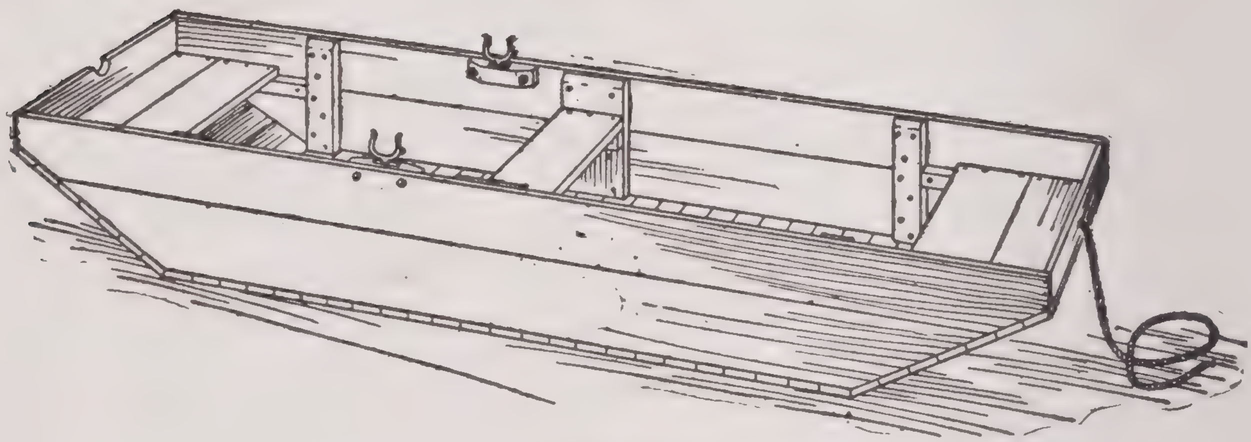


FIG. 435.

FIG. 435. — A Home-made Punt.
FIG. 436. — How the Bottom Boards are Put On.
FIG. 437. — Bevel off the Bottom Edge of the Stem and Stern Pieces.

have plain edges, not tongued and grooved, and the seats may be made of any scraps you have on hand.

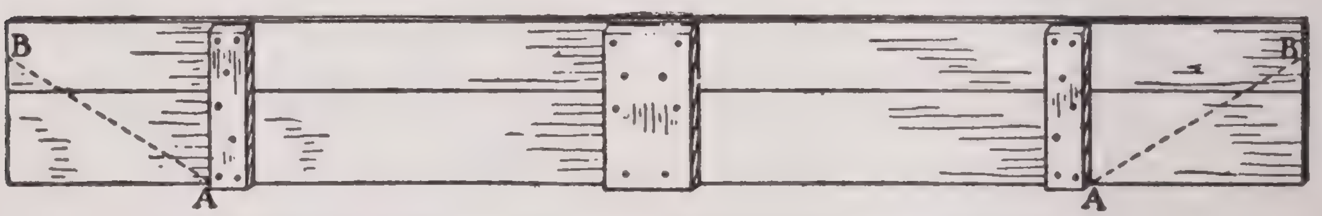



FIG. 438. — Batten Together the Side Boards like this.

Figure 438 shows how

**The Side Boards** should be battened together. Make the center batten 10 inches wide and the other two battens about 4 inches wide; fasten the latter in place about

24 inches from the ends. Short nails will not hold such pieces as battens very well, and the clinching of long nails, where they are exposed to view, is not very desirable, so it is a good plan to use screws of the proper length for the purpose.

When the boards of the side pieces have been battened together, locate the points *B* 4 inches below the top edge, then connect them with points *A* by the diagonal lines *AB*, as shown, and saw off the ends on these lines.

**Cut the Stem and Stern Pieces** 4 inches wide and 3 feet 4 inches long, then turn the side pieces over on their top edge as shown in Fig. 436, and fit these pieces between their ends.

**Cut the Bottom Boards** 3 feet 6 inches long, out of the 4-inch or 6-inch boards mentioned before. Coat the edges of the side pieces and the edges of each bottom board with white lead, and drive each board as close as possible to the preceding piece. Use copper or galvanized nails for fastening the boards; these will stand the exposure to water, but wire or wrought-iron nails without galvanizing will not, and will soon rust through and break off.

The bottom edge of the stem and stern pieces will have to be beveled off with a plane as shown in Fig. 437, as will also one edge of the first and last bottom boards, and one edge of the bottom boards at the ridges, in order to make the boards fit together perfectly at those points.

**Fasten an Inner Keel Board** to the bottom of your boat along the center, from bow to stern, as a protection to

the bottom boards, and nail a cleat to it in the proper place to brace your feet against while rowing.

Figure 435 shows the arrangement of the three

**Seats**. Fasten these to cleats placed about 3 inches below the top of the sides. Make the center seat out of a 10-inch board, and the end seats out of a 10-inch and an 8-inch board (which will make them about 18 inches wide), and nail a short batten across the under side of the end seats as shown in Fig. 439, to prevent them from springing apart and catching one's clothes between them.

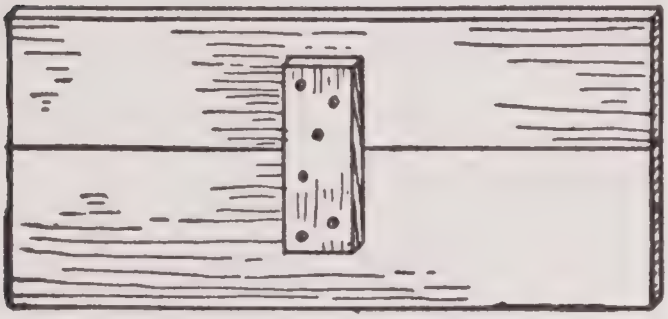


FIG. 439. — The End Seat.

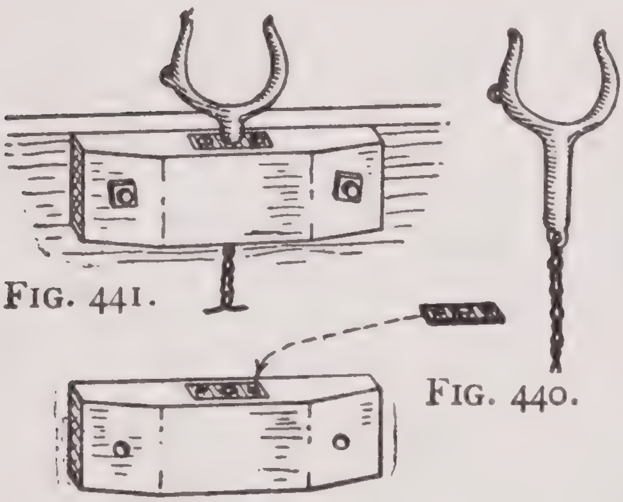


FIG. 441.

FIG. 440.

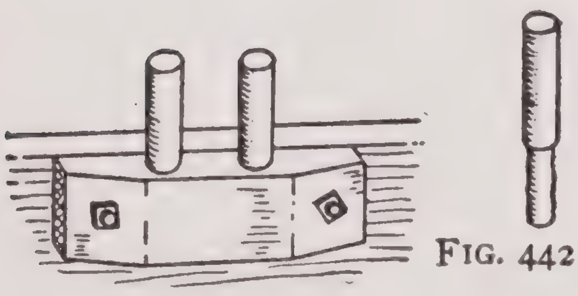


FIG. 442.

FIG. 443.

FIGS. 440 and 441. — Rowlocks.
FIGS. 442 and 443. — Thole-pins

**Rowlocks.** A pair of galvanized wrought-iron rowlocks, of the form shown in Fig. 440, can be purchased for 25 or 30 cents, and it is an easy matter to make the socket blocks for them to set in (Fig. 441). Cut two blocks about 8 inches long, $1\frac{1}{4}$ inches wide, and 2 inches thick; bevel the ends, and bore a $\frac{1}{4}$-inch hole near each

end for bolting, and a $\frac{1}{2}$-inch hole from the center of the top down through each for the rowlock to drop into. The socket plate (Fig. 440), which comes with the rowlock, should be set into the block flush with the top. Bolt the blocks to the sides of the punt (Fig. 441) so the centers will be 14 inches from the center of the center seat.

In case you cannot conveniently get rowlocks,

**Thole-pins** may be made and used as a substitute. Figure 442 shows a pin cut from a piece of broom-handle, and Fig. 443 shows how a pair of them should be set into holes bored in a block similar to those shown for the rowlocks. The holes for the pins should be placed about 3 inches apart.

**The Painter** may be knotted on the end and slipped through a hole bored in the stem piece, and a circular notch may be cut in the top edge of the stern piece to admit an oar or paddle for steering.

**Finishing**. Set all nail-heads, putty up the holes thus made, and all other holes and defects, and then give the boat two or three coats of lead paint, inside and out, in color to suit your taste.

# CHAPTER XXIII

## A HOME-MADE SHARPIE

ALTHOUGH there is more work to the construction of a sharpie than the punt described in the last chapter, it is much easier to row on account of its wedge-shaped bow; at the same time, the material required will cost no more than that for the other boat. The flat-bottom boat is generally considered one of the best forms of cheap rowboats, and you will find it in common use

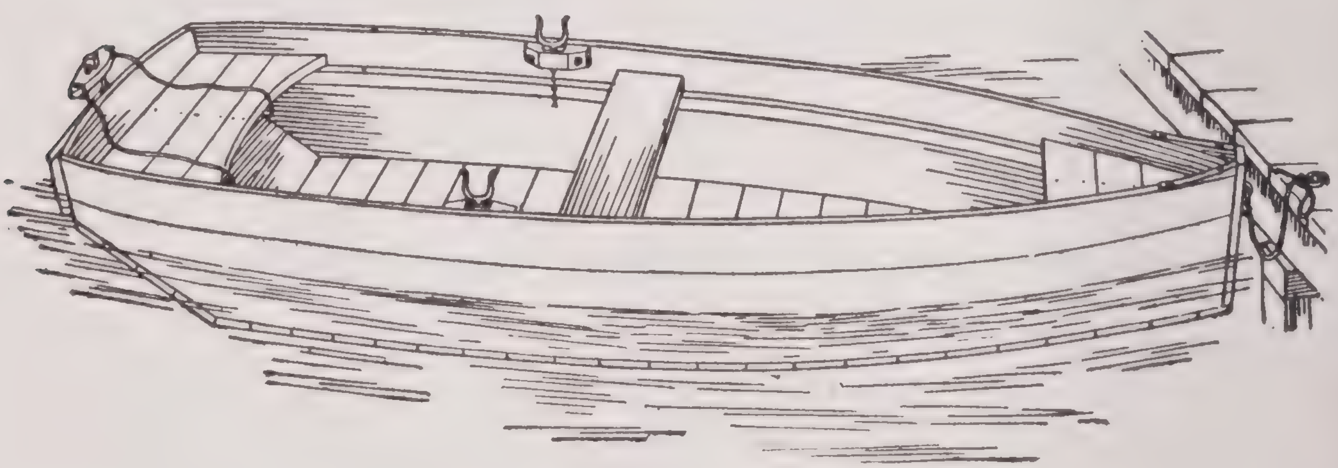


FIG. 444. — A Home-made Sharpie.

upon the rivers and small lakes, at summer resorts and at private piers. It is not difficult to build one.

**Dimensions.** Figure 444 shows a sharpie 13 feet long, 3 feet 6 inches wide amidships, and 18 inches deep.

You may alter these proportions if you wish, but, in case you do, draw out your revised plan and figure out the sizes for all the pieces before beginning work, so that every part will fit properly.

As it is difficult to get boards wider than 14 inches,

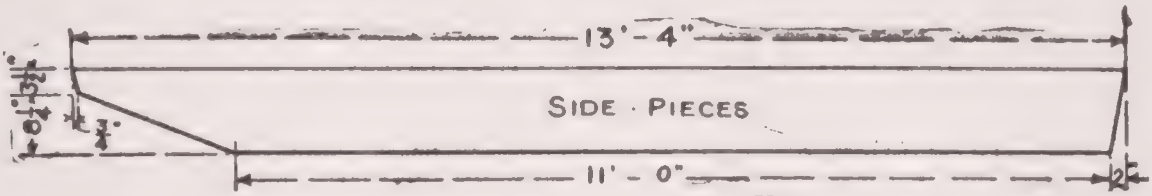



FIG. 445.

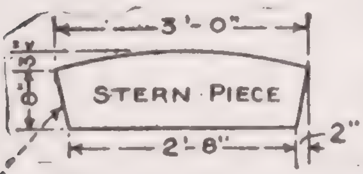



FIG. 447.

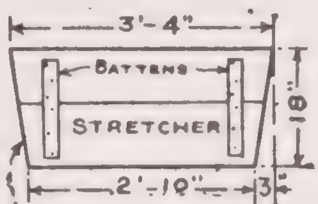



FIG. 448.

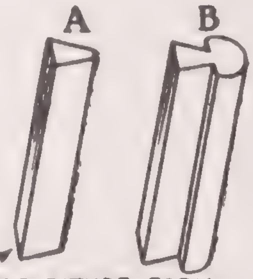



FIG. 446.

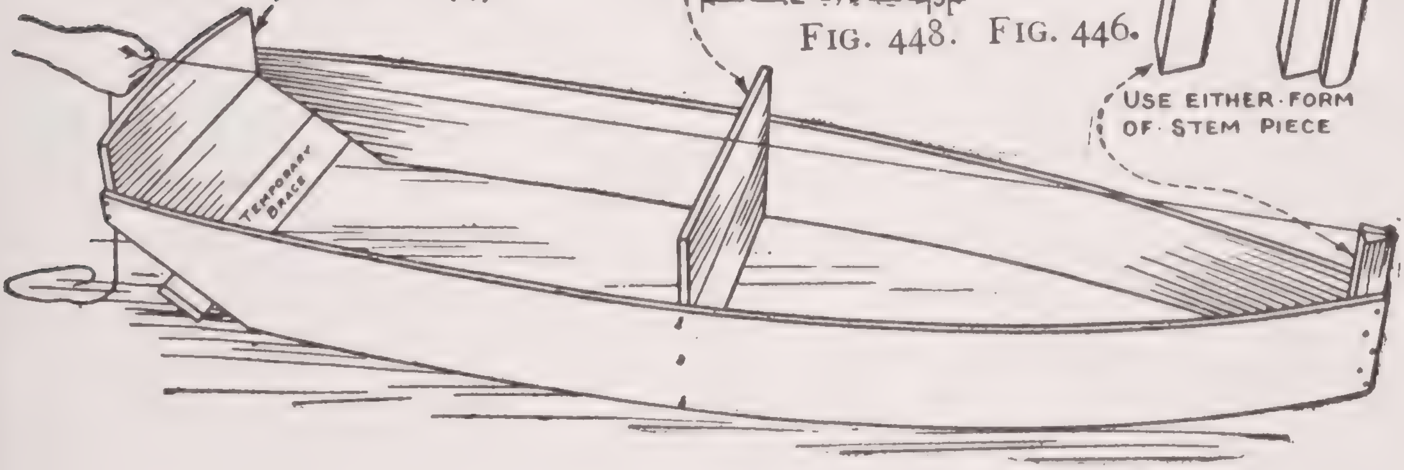



FIG. 449.

FIG. 445. — Pattern for the Side Pieces.
FIG. 446. — Two Forms of Stem-piece.
FIG. 447. — Pattern for the Stern-piece.
FIG. 448. — Pattern for the Stretcher.
FIG. 449. — How the Above Pieces are put Together.

and 12 inches is usually the widest stock material, you will have to use either a 12-inch and a 6-inch board, or a 10-inch and an 8-inch board, for

**The Side Pieces.** The boards should be of 1-inch stock,

and should be dressed on both sides. Figure 445 shows the pattern for the lower boards, with the dimensions for cutting the slants on the bow and stern ends.

**Cut the Stem-piece** like one of the forms shown in Fig. 446. *A* is the simpler form to cut, but *B* makes the neater appearing bow, as it finishes off the ends of the side pieces; the side boards fit into the rabbets cut in the sides of piece *B*. If form *A* is used, the ends of the side pieces must be finished off by nailing a strip 3 inches wide to the edges of the side pieces and the stem-piece (*C*, Fig. 452).

Figure 447 shows the pattern for

**The Stern-piece**, and Fig. 448 shows the pattern for

**The Stretcher**, both of which should be prepared as soon as the stem-piece has been cut.

**To put together** the sides, stem-and stern-pieces, and the stretcher (Fig. 449), first nail the ends of the side pieces to the stem-piece, then nail them to the ends of the stretcher, which should be placed in the exact center of the length of the sides. Draw the stern ends toward each other until they are of the required distance apart for the stern-piece to fit between, and tack a temporary piece across the edges to hold them in position (Fig. 449). It is necessary to bend each side piece the same amount, in order to turn out a boat which will not have a tendency to swerve to one side with each stroke of the oars, and the best way to get the sides symmetrical is by attaching a cord to a nail driven into the center of the

end of the stem-piece, stretching it along the entire length of the boat and holding it at the center of the stern-piece (Fig. 449); if this crosses the center of the stretcher, you may know that the work is right, and you can fasten the stern ends permanently in place; if it does not cross the stretcher at the center, it will be a simple matter to bend one side piece a little more and the other a little less, until the string crosses the center of the bow, stern, and stretcher in a straight line.

The stretcher may be fastened permanently in place, or the nails may be driven part way in (Fig. 450) so

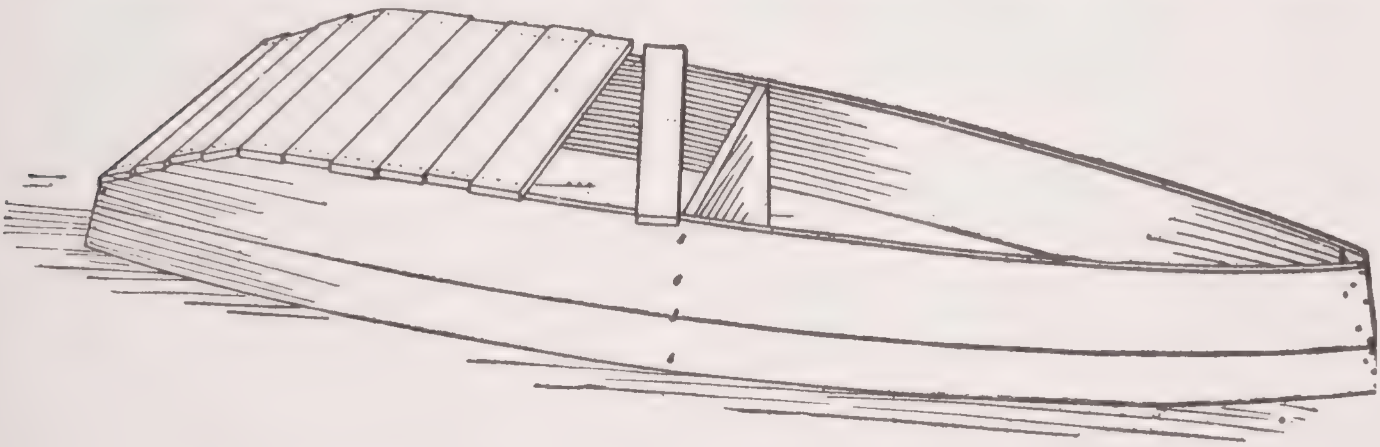


FIG. 450. — How the Bottom Boards are put On.

they may be removed and the stretcher taken out after the center seat has been put in place and the bracing is no longer required. The top boards of the sides should be nailed on as soon as the framework has been trued up, and the ends of these should be cut off even with the stem- and stern-pieces.

**The Bottom Boards** should be either 4-inch or 6-inch boards of 1-inch stock, dressed on two sides and two edges. Get the dryest material you can, for the pieces

must not shrink to any marked degree after being put in place or the seams will open and cause the boat to leak; dry stuff will swell when exposed to the water, and the seams will close up very tight. The boards must not have tongued-and-grooved edges. Before putting on the boards, it will be necessary to plane off the bottom edges of the side pieces, because, as a result of the change in the twist of the boards between the bow and stern, these edges will be slightly curved. Do this work carefully so as to provide a straight and true surface to nail the bottom to. Cut the boards a little longer than is necessary, and then, starting at the stern end, nail the pieces in place, driving each board as tight as possible against the preceding piece. The edges of the boards and the side pieces should be given a thick coat of white lead to caulk up the seams. See instructions given for putting on the bottom of the *Punt* (page 353).

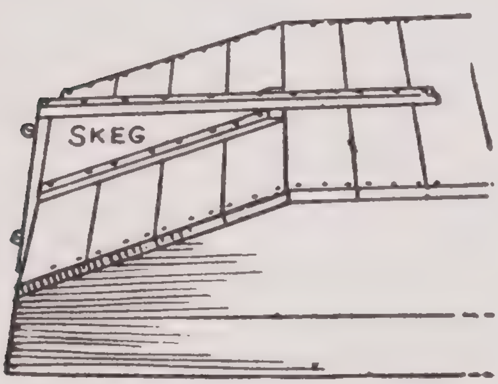


FIG. 451. — Attachment of Skeg.

It will not be necessary to attach a keel along the entire length of the bottom of the boat, but

**A Skeg** should be prepared for the sloping stern as shown in Fig. 451. This triangular piece may be cut out of 1-inch stuff and should be of the proper size so, when nailed in place, the lower edge will line up with the straight part of the bottom of the boat, and the end will

line up with the face of the stern-piece. The illustration shows how the piece should be attached and braced with small wooden strips. The skeg must be in an exact line with the center of the bow and stern; its position can be determined by stretching a cord through the centers. The strip at the end of the skeg not only holds this piece to the stern, but forms a strip in which to screw the screw-eyes for the rudder hooks.

**Fasten an Inner Keel Board** in the bottom as described on page 353 for the *Punt*.

**Seats** should be fastened in the bow and stern ends and in the center as shown in Fig. 444. These should be supported upon cleats, and the neatest way to put on the cleats is to make them continuous as shown in the illustration, and fasten them low enough so they will cover the seams between the side boards. Batten together the pieces of the bow and stern seats as shown in Fig. 439, page 354.

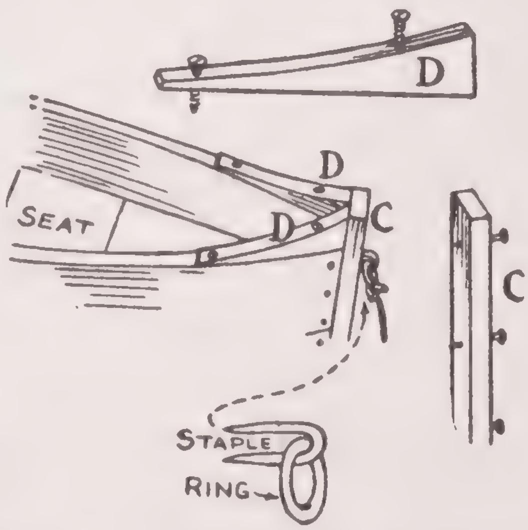


FIG. 452.— Finishing of Bow.

**The Bow of the Boat** should be completed next. If you have made a wedge-shaped stem-piece (*A*, Fig. 446), cut strip *C* (Fig. 452) 3 inches wide, and long enough to extend from $1\frac{1}{2}$ inches above the stem-piece down to the under side of the bottom boards; then prepare two triangular pieces similar to *D* to fit against strip *C*, and screw them in place as shown. If stem-piece

*B* was used (Fig. 446), fit two pieces similar to *D* (Fig. 452) against it in the same way.

**For the Painter** secure a small staple, and a yacht or harness iron ring, and attach these to the bow as shown in Fig. 452.

**An Easily Made Rudder** is shown in Figs. 453 to 457. Figure 453 shows it completed; Fig. 454 shows how screw-eyes are screwed into the strip fastened to the stern-piece,

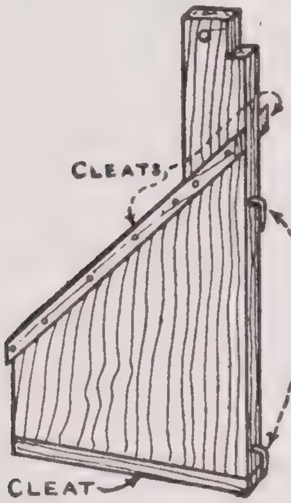



FIG. 455.

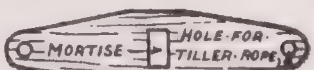



FIG. 457.

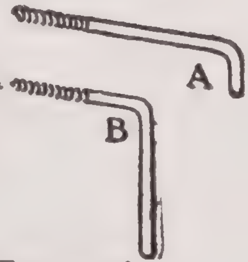



FIG. 456.

FIG. 453.

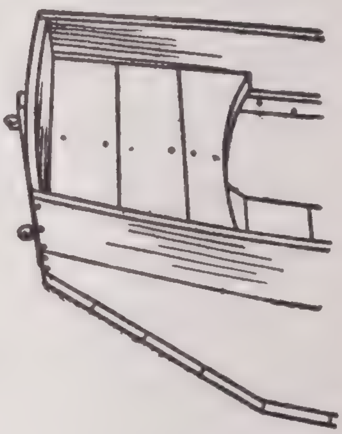


FIG. 454.

FIGS. 453–457. — Details of an Easily Made Rudder.

into which to hook the rudder hooks; and Figs. 455, 456, and 457 show the details for constructing the rudder.

The cross-bar of the rudder (Fig. 457) should be mortised to receive the end of the rudder, as shown, and a hole should be bored through the rudder through which to drive a pin to hold the cross-bar in place (Fig. 455). Get two 7-inch iron hooks (*A*, Fig. 456), bend the ends out straight, and then bend a new 4-inch hook on each (*B*, Fig. 456). Screw these hooks in the

proper positions so they will hook into the screw-eyes in the stern.

**The Rowlock Blocks** should be prepared and attached as shown in Fig. 441 or Fig. 443, page 354, and either

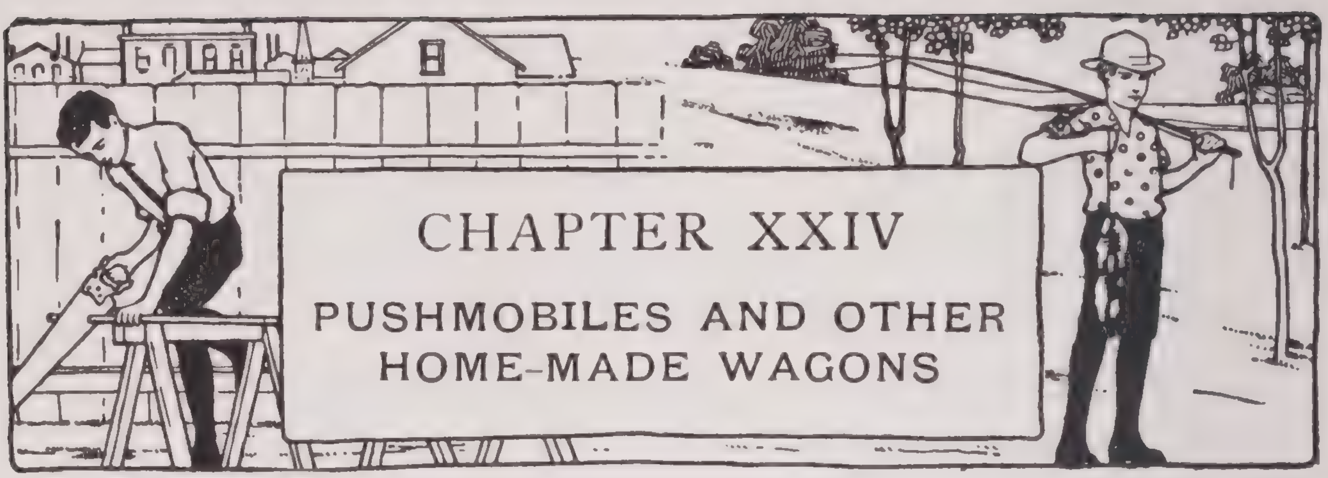
**Rowlocks or Thole-pins** should be fitted into them (Figs. 440 and 442, page 354).

**Finish the Boat** as directed for the *Punt* (see page 355).

**For An Outboard Motor,** use 2-inch stock for the stern-piece, and make it several inches wider than the side pieces. The boat bottom will be flat instead of sloping, at the stern.

Another way to build the sides is to fasten vertical battens across the boards. Arrange these to come at the seats, one on each side of each seat. Then nail cleats across the battens to support the seats.

**Other Boat Plans.** You will find plans for other forms of boats and water craft in Chapters XXX, XXXI, XXXII, XXXIII, XXXIV, XXXV and XXXVI, of "Outdoor Boy Craftsmen," and Chapters XXVIII and XXIX of "Big Book of Boys' Hobbies."




# CHAPTER XXIV

## PUSHMOBILES AND OTHER HOME-MADE WAGONS

WITH the necessary wheels in hand, it is possible to make all sorts of wagons, from a simple two-wheeled dog-cart to a model automobile. There are a number of sources from which a boy can procure wheels if he doesn't own any. Oftentimes a pair can be picked up at a second-hand store or at a junk shop, for 50 or 75 cents a pair; sometimes a neighbor who has a grown son can find a few for you by a little rummaging through the basement or attic; and often you will run across a boy with whom you can strike a bargain. Wagon, bicycle, tricycle, velocipede, and baby-carriage wheels may be used.

**A Pushmobile** is a unique form of home-made wagon that has been developed from the simple wagons which the boys used to make for coasting, and for pushing from behind, when the automobile was unknown. It is patterned as nearly as possible after an automobile, and it is pushed by the mechanician, who runs behind, while the driver rides and attends to the steering. Working details for making one of these unique wagons are shown in Figs. 458 to 471.

Paul Towne of Flushing, Long Island, was probably the first boy to build a pushmobile, and as a result of the rivalry which sprang up among the boys who made

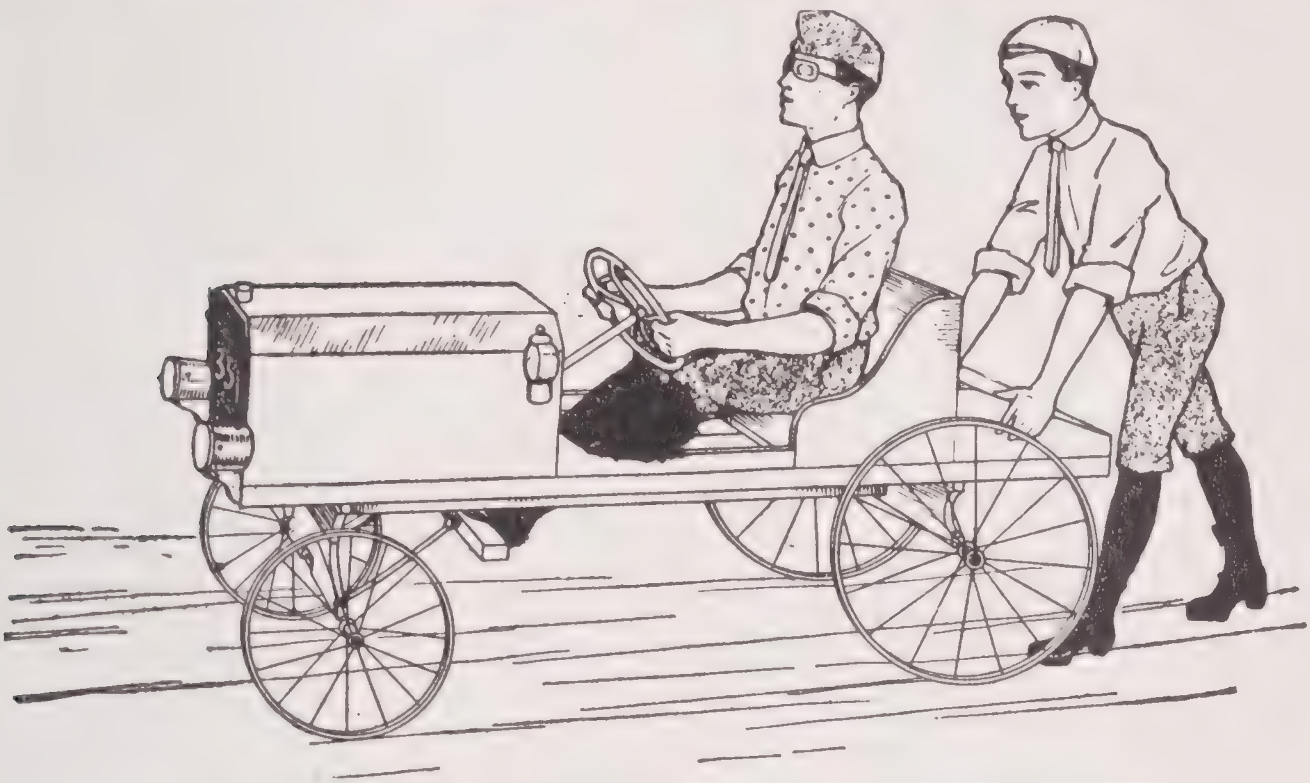


FIG. 458. — A Pushmobile.

similar "machines," each of whom claimed superior advantages for his car,

**The Flushing Pushmobile Club** was organized in the autumn of 1906 for the purpose of promoting pushmobile races. The *Brooklyn Daily Times* of Dec. 15, 1906, contained an interesting account of the work of the club, from which the following details of several of its races are taken: —

"The Flushing Club has held three great races during its active career. The first was an intersuburban affair and was to determine whether championship honors should go to Flushing, College Point, or Bayside, membership in the club being from all these 'foreign' countries. The honors in this race went to Flushing, for President Paul

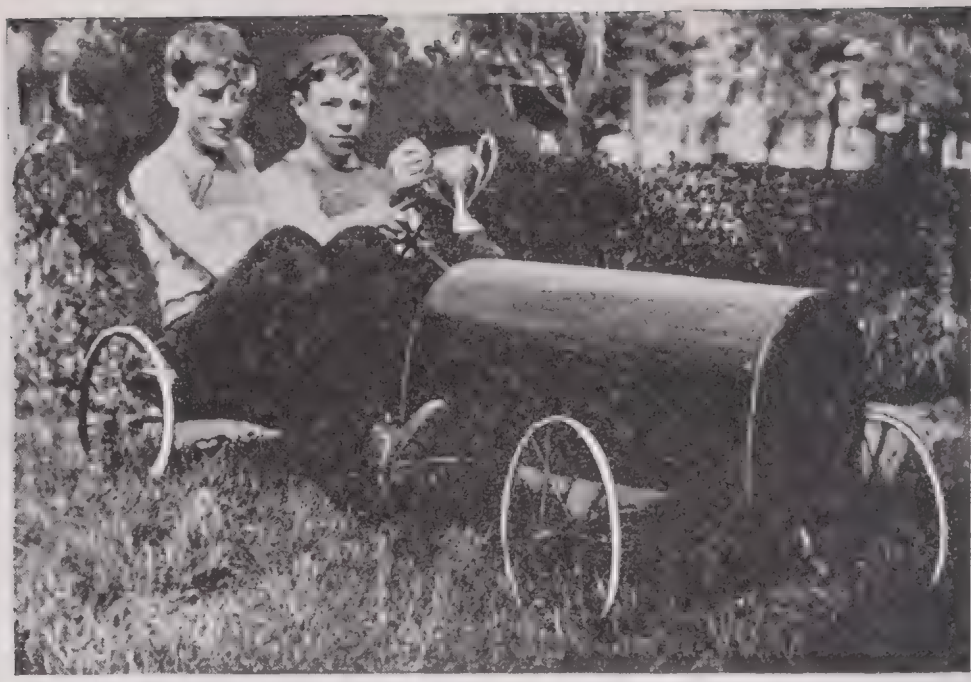
Towne and his brother Herbert were the winners. The second race was for the Vanderbilt cup, so called. Many of the Murray Hill and Flushing merchants contributed toward it, but the largest individual subscription came from Mr. Vanderbilt. The trophy was valued at over $50. According to the deed of gift the trophy must be won three times to become the property of the winner. The first race for this cup ended in a fluke, for the car winning the race was protested. It was then decided that the race should be run over. The second event was won by Brown and Lawrence, who won the first race. This was a very popular victory under the circumstances. The third big event was a race for the Reiger cup, a beautiful trophy presented by Charles Reiger of Flushing. This event brought out the full strength of the club, for there were twenty cars in the race. The trophy was won by Donahue and Johnson."

The photographs opposite page 364 show several of the competing machines, while those opposite this page show the start of one of the club's races and one of the winning teams. The winning team in

**The Vanderbilt Cup Race** covered the course, which was ten times around a city block, in 27 minutes and 12 seconds. This was one of the most interesting races.

You will notice by the photographs that the boys have shown considerable ingenuity in working out the plans for their pushmobiles. Various kinds and sizes of wheels have been used; some of the bodies are built low and others high; some of the models have been copied after foreign racing machines, and others have been patterned after roadsters and runabouts. The hoods have been made of grocery boxes, sheet metal, barrel hoops covered with canvas, or built up with box boards; and one boy, who wanted to get the pointed nose effect of the


Some of the Competing Cars in the Flushing Pushmobile Club Races.



Winning Car in the Vanderbilt Cup Race.


At the Start Off. A Flushing Pushmobile Club Race.

French racer, used the sawed-off bow of a row boat for his. To furnish the "chug," "chug," and "smell" of the automobile, one lad equipped a dummy car with a gasoline engine, and this was run over the course for the benefit of the spectators.

The *Brooklyn Daily Times* published the following interesting

**Description of a Pushmobile Race:—**

"Is a pushmobile race exciting? Ask any of the hundreds of spectators who crowd the course. They will tell you that it is almost as interesting as a real auto race. There will be men and women with score-cards, pencils, and stop-watches. The cars are timed for each lap. Seconds count as much, if not more, than in the big races. The cars come singly, three, four, and half a dozen at a time. It takes an expert to keep all the records accurately. This car is now ahead, and then that one leads. One car is gaining a lap on all the rest and looks like a winner. There are spurts in which the boys on the cars use every bit of strength and endurance they possess. As the contest comes to a close, it is seen that some two or three are leading. Now if no accident happens, if only there is not a breakdown! That is the hope expressed by each man and woman with the score-card. Then the rush for the finish. The first car to complete the ten laps, and then the figuring for elapsed time, and finally the declaration of the winner and the shouts for the successful car."

Now, boys, if you have not become fired with enthusiasm after reading the above accounts of the work of the Flushing Pushmobile Club, the author has missed his guess; if you *have*, get to work and construct a machine like the one shown in Fig. 458 and described upon the following pages, then show it to your boy friends, and the

chances are there will be enough machines in your town within a few days to make it possible to

**Organize a Pushmobile Club**, or to make pushmobile racing a feature of your present neighborhood or school club.

**To construct a Pushmobile.** When procuring wheels for a pushmobile, get the iron axle rods and nuts and washers that belong to the wheels, if possible; it will be easy enough to refit nuts and washers to the axles if they are lost, but if you cannot get the axles or find another pair that will do, you will have

**To make New Axles.** A couple of round iron rods of the proper diameter to fit the hubs of your wheels can be procured at almost any hardware store, wagon shop, or blacksmith shop, and you can have them cut to the proper length, threaded for nuts, and drilled in two places near each end, by a machinist, plumber, or gas-fitter. You will have to decide upon the width of your wagon before you can determine the length for the rods, and of course the length of the wheel hubs will have to be considered also. The first hole in the rod is provided for an iron pin, the purpose of which is to keep the wheel from running too far back on the axle, and the second hole is made for a stove-bolt or screw for fastening the iron axle to the wooden axle and wagon-bed (Figs. 477 and 478).

**The Wooden Axles** should be constructed first (Figs. 459 and 460). The sizes of these will depend upon the

length of the iron axles, the height of the wheels, and whether you want a high or low body. The drawings show a machine with a body that is higher than most of

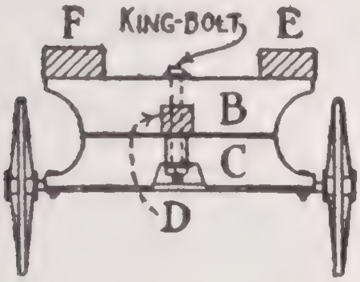



FIG. 460. — The Front Axle.

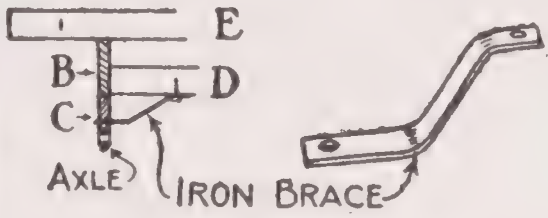



FIG. 461. — Brace for the Front Axle.

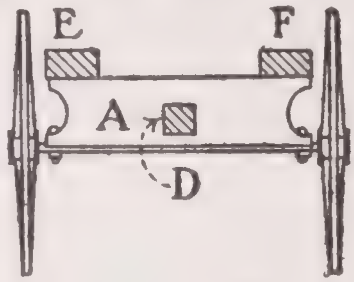



FIG. 459. — The Rear Axle.

those shown in the photographs, but this makes a car that is easier for the mechanician to push, for he does not have to stoop over as much. After cutting out piece *A*, you must make *B* and *C* of the proper widths so the top of *B* will be level with the top of *A* when the wheels are in place. *C* is fastened to *B* by means of a king-bolt (Fig. 460).

Connect the wooden axles by means of a piece of 2-by-2 (*D*, Figs. 459 to 462), and brace the king-bolt of the front axle to this strip with an iron strap, to prevent it from bending (Fig. 461); the brace should be about $\frac{1}{8}$ inch thick and 1 inch wide, and should be bent and drilled as shown in Fig. 461.

**The Wagon-bed** pieces *E* and *F* are 2-by-4's and connect the tops of axle pieces *A* and *B*, to which they are nailed. These will be of whatever length you have determined to make your car.

**For the Steering-wheel** get an old sewing-machine driving-wheel, if possible, and use a broom-handle for a

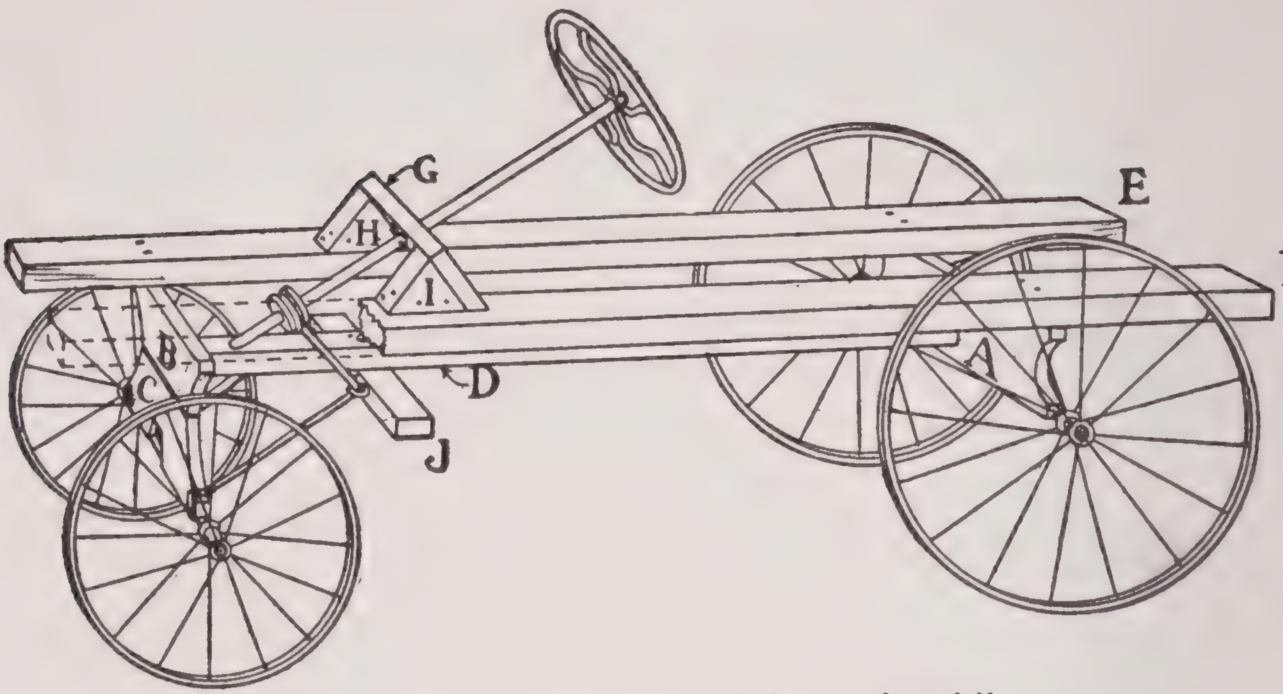



FIG. 462. — Framework of the Pushmobile.
(The front end of the strip *F* is broken off so that you can see the steering-gear.)

shaft (Fig. 463). Screw the wheel to the end of the broom-handle (Fig. 465). If you cannot get a sewing-machine wheel, a wooden or iron wagon-wheel may be wired to the end of the broom-handle (Fig. 466). The shaft must be provided with a *drum* upon which to fasten the steering ropes (Figs. 462 and 463), and this drum should be made out of three circular blocks as shown in Fig. 464. Lay out the center block 3 inches in diameter, and the outer, or flange, blocks 4 inches in diameter, and before cutting them out

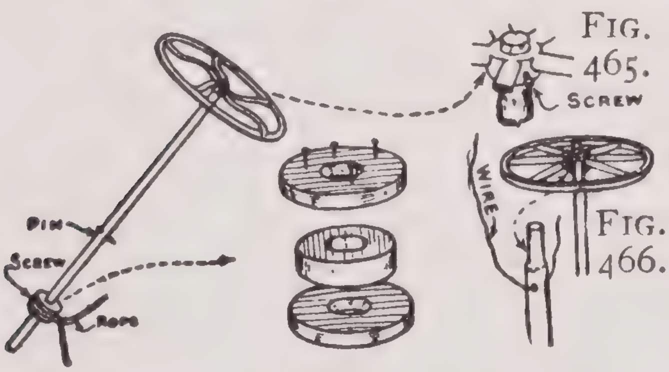



FIG. 463. FIG. 464.

FIG. 463. — Steering-wheel and Shaft for the Pushmobile.

FIG. 464. — Three Disks like these for Drum of Steering-wheel Shaft.

FIG. 465. — How to attach a Sewing-machine Wheel to a Broom-handle.

FIG. 466. — How to wire a Wagon Wheel to a Broom-handle.

bore a 1-inch hole through the center of each. Nail the blocks together, and slip the completed drum over the end of the broom-handle; but do not fasten the drum in place until after you have mounted the shaft on the framework.

Fasten a board to the wagon-bed, as shown at *G* (Fig. 462), on blocks similar to *H* and *I*; the blocks must be cut to the proper slant so the position of the board will be at right angles to the steering-wheel shaft. Then fasten the cross-piece *J* to the under side of strip *D* with a bolt and nails. Board *G* should have a 1-inch hole bored through its center for the steering shaft to turn in, and a hole should be bored part way through strip *D*, directly in line with the hole in *G*, for a socket for the end of the shaft. To connect the drum on the shaft to the wheels, take some strong rope, pass it around the drum, cross the ends on the under side (Fig. 463), run them through screw-eyes screwed into the cross-piece *J* on each side of strip *D*, and attach them to the ends of the wooden axle. It is important to cross the rope after passing it around the drum, for otherwise the pushmobile would turn to the left when you turn the wheel to the right, and *vice versa*.

When the steering-gear has been carefully adjusted, fasten the drum to the shaft with a screw, and screw or nail the steering line to the drum; also drive a pin into the broom-handle about $\frac{1}{4}$ inch in front of board *G* to prevent the shaft from pulling out of place (Figs. 462 and 463).

When the frame of the pushmobile has been completed, it is a simple matter to finish the body.

**The Hood** is made out of a box with the cover and bottom removed, and a three-sided top constructed upon it. If you cannot find a box of the right size, you can cut down a large box or build the hood out of boards. Figures 458

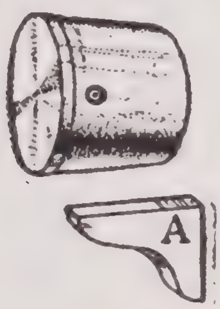
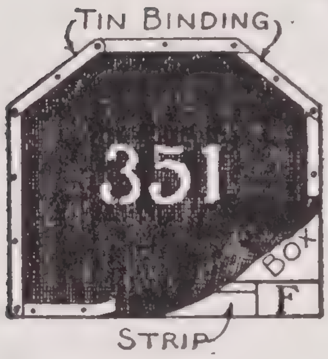



FIG. 468.


FIG. 469.

FIG. 470.



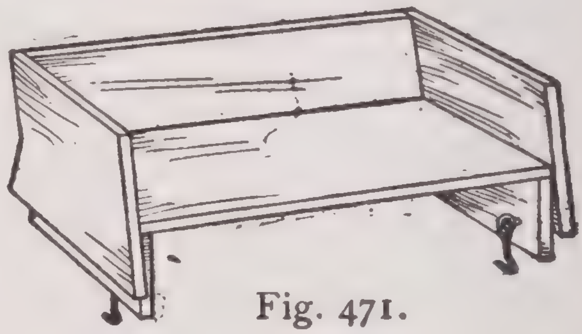



Fig. 471.

FIG. 467.

FIG. 467. — Radiator-front.
FIG. 468. — Lard-can Headlight and Bracket.
FIG. 469. — Clock-case and Can for Side Lamps.
FIG. 470. — The Completed Clock-case Side Lamp.
FIG. 471. — Seat for Auto Wagon.

and 467 show the shape of the top. Fasten a small pill box to the top of the hood, as shown, for the cap to the "radiator" (Fig. 458).

After fastening the hood to the frame of the pushmobile, tack a piece of screen wire over the front for

**The Radiator-front**, and then attach a strip of tin around the edge, as shown in Fig. 467, to finish it off.

**The Seat**, back, and arms of the body are made out of a box cut down, and the rear end is built up of boards.

**Headlights.** Two lard cans with their covers fitted on make splendid imitation headlights (Fig. 468). Cut two wooden brackets similar to *A* (Fig. 468), nail or screw them to the sides of the radiator-front, and then nail or screw the cans to the brackets and to the radiator-front.

**Side Lamps.** Bicycle lamps may be used for these, or you can make lamps out of the cases of two old alarm-clocks (Figs. 469 and 470).

**To make a Clock-case Side Lamp**, remove the works from the case and put back the screws necessary to hold the glass in place; then cut a $\frac{3}{4}$-inch hole through the center of the bottom for the candle, and wire the case to the top of a small tin can of about the size of a 1-pound paint can, punching holes through the clock-case and the can through which to run the wire. The candle sets down in the can and is lighted by removing the tin back of the clock-case. Nail or screw the case to the side of the hood.

**Paint your Machine** with two coats of paint, using any color you choose. Of course you will want to make the body of one color and the trimmings of another.

**Paint your License Number** upon the radiator-front with white or red paint, or use last year's auto license plates.

**A Racing Pushmobile** may have a much simpler body than the machine just described, or you may make por-

tions removable so the machine may be dismantled for a race.

**An Auto Wagon.** The wagon shown in Fig. 472 has a body built similar to that of the pushmobile, except that

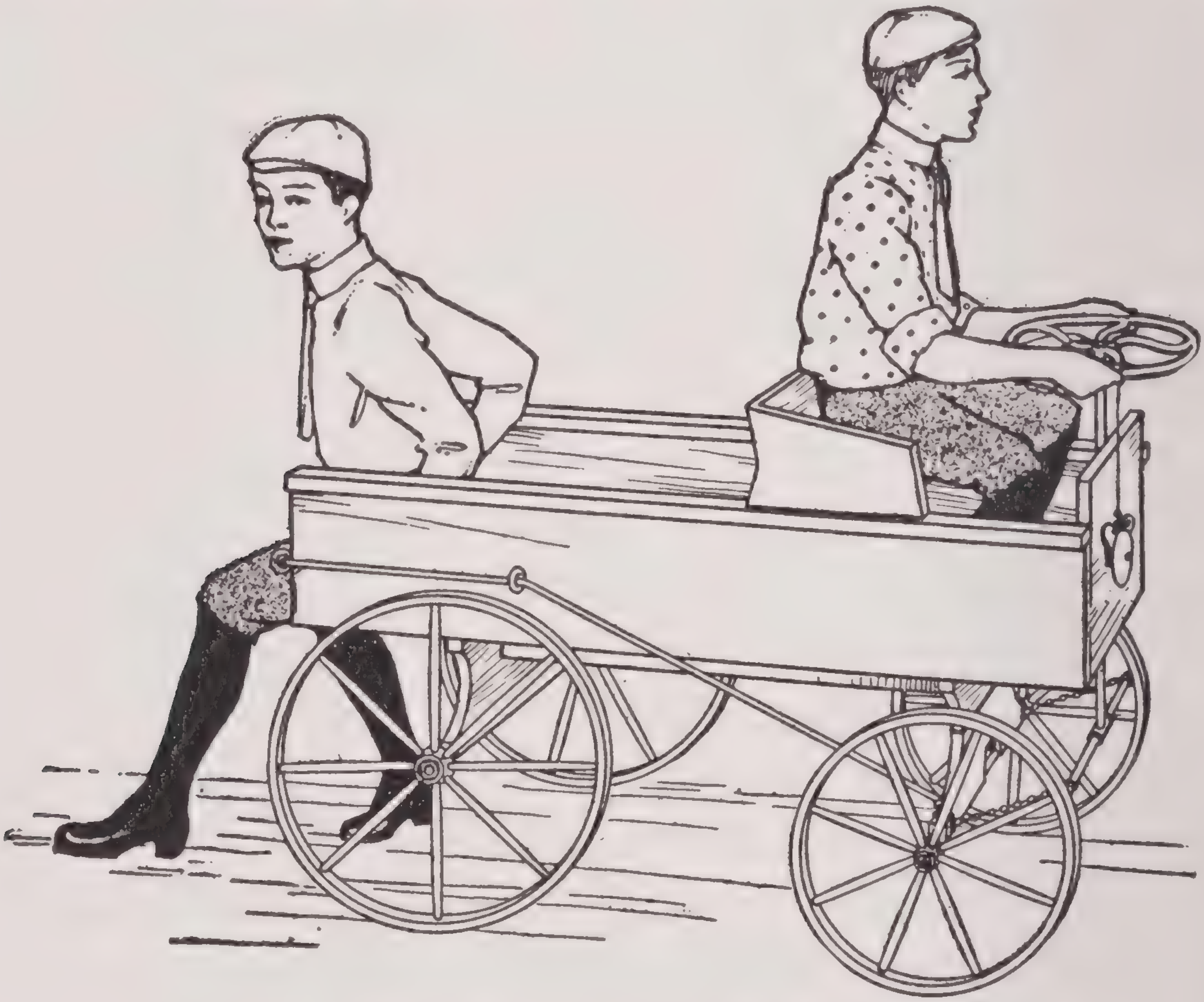


FIG. 472. — An Auto Wagon.

the bed is made solid out of boards 1 inch thick. Make the sides out of 8-inch boards with a 2-inch strip nailed along the top edge, and make the dashboard out of two pieces of board battened together.

**The Steering-wheel** should be made out of a sewing-machine wheel and piece of gas-pipe as shown in Fig. 473. Get a gas-fitter to prepare a piece of gas-pipe with

a T connection at one end, and a short piece of pipe run through the T crosswise, as shown in the illustration, and have him drill a hole through the vertical piece of pipe near the upper end, and two holes through the cross-piece — one near each end. Screw two screw-eyes into the inside face of the dashboard, then slip the steering shaft through a hole bored through the bottom of the wagon-bed, and through the screw-eyes. Fasten the wheel to the end of the pipe by means of a metal pin driven through the hole in the pipe and wheel hub, wrap some wire around the pipe on a line with the top of the dashboard, and solder it in place, to keep the pipe from slipping down (Fig. 473), and run rope or chain from the ends of the lower cross-piece to the axle ends.

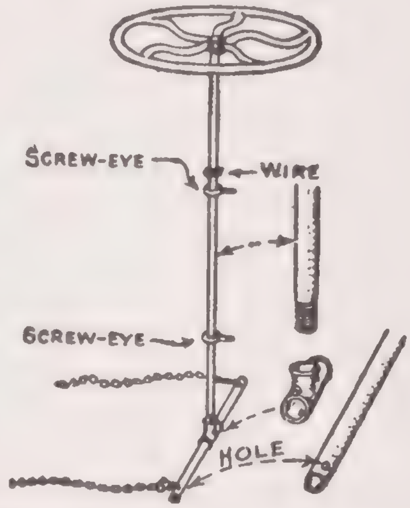


FIG. 473. — Details of a Sewing-machine Wheel and Gas-pipe Steering wheel.

**Another Steering-gear.** The steering shaft and cross-piece may be made of wood, but of course the iron pipe scheme is much stronger and is much better in the case of the auto wagon, where the weight of the driver comes directly over the wheels, bringing a greater strain upon each part. If you want to, you may rig up a dummy steering-wheel and shaft, and provide for steering by running ropes from the axle ends around the sides of the wagon to the back, where the mechanician can attend to it. It might be a good plan to provide for this method of steering, anyway, so in case you give a child

a ride at any time you can place him in the front seat and do the steering yourself from the rear.

**Build the Seat** as shown in Fig. 471, and screw a hook into each end of the seat, and a screw-eye into each side of the wagon in the proper position for it to hook into, to hold it securely to the wagon sides.

**Procure an Auto Horn** for the front of the dashboard, or fasten an electric bell upon it and place a dry battery inside of the wagon.

Figure 474 shows

**A Simple Push Wagon.** A 2-inch plank, 6 or 8 inches in width, should be procured for

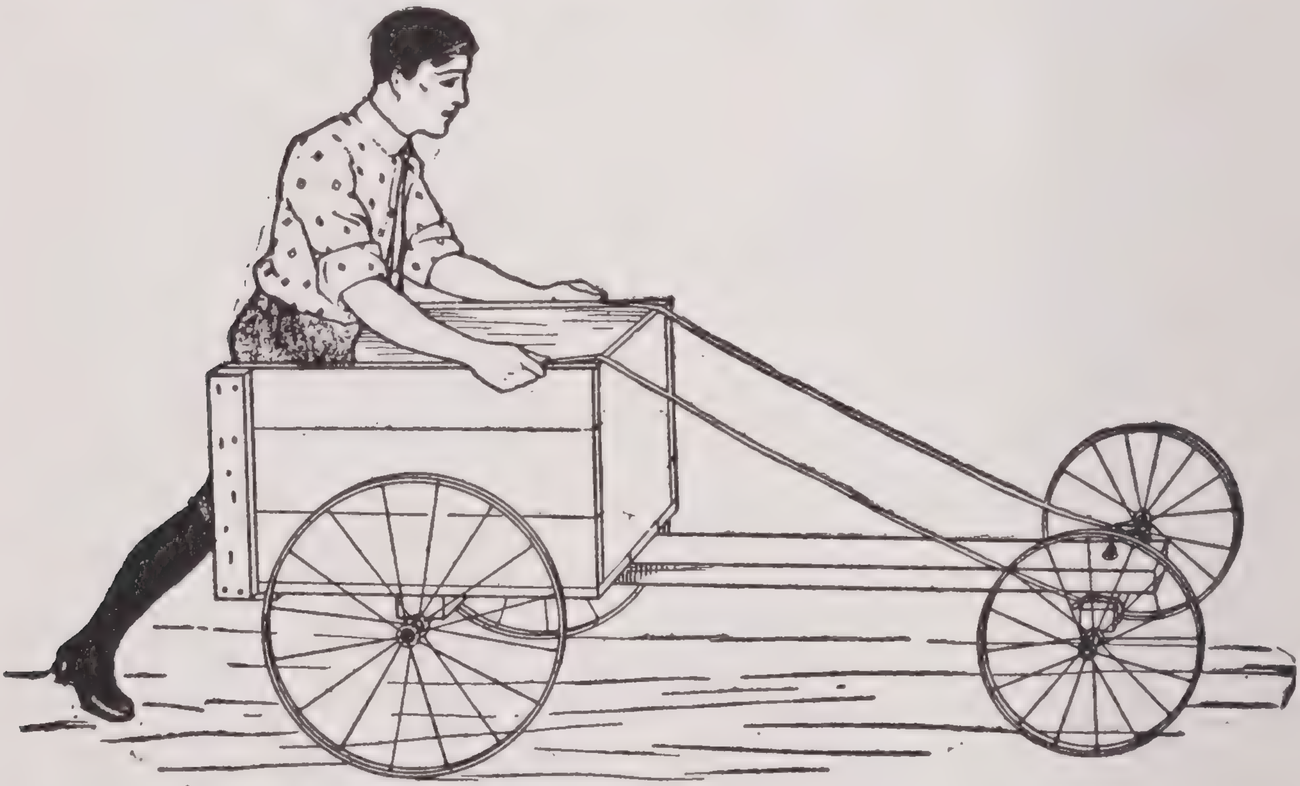


FIG. 474. — A Simple Push Wagon.

**The Wagon-bed**; a board 1 inch thick may be used, but of course it will not have the stiffness that the thicker piece would have. Also get a strong box,

knock out one end, nail a cleat to the ends of the side and bottom boards to hold them together, and fasten the box to one end of the wagon-bed as shown in Figs. 474 and 475.

**The Rear Wheels** should be 16 or 18 inches in diameter and should set under the center of the box (Fig. 475). Nail two blocks of the same thickness as the wagon-bed to the bottom of the box, and fasten the axle across them

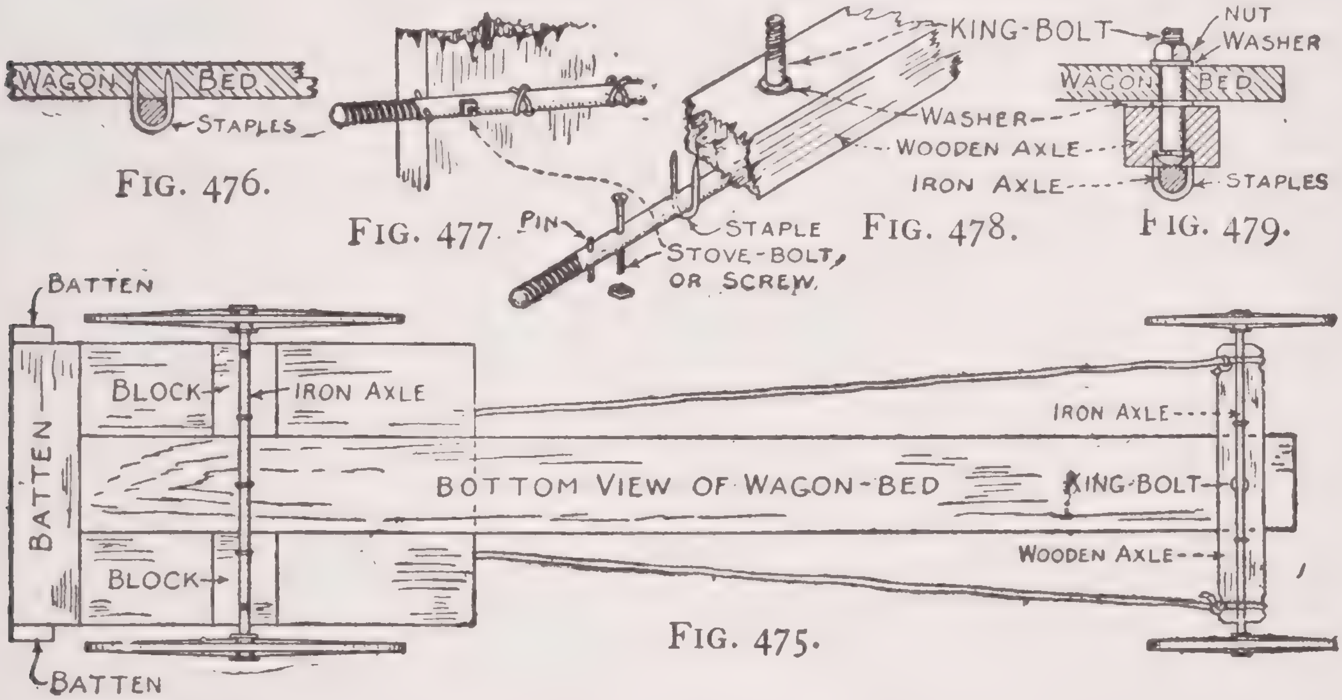


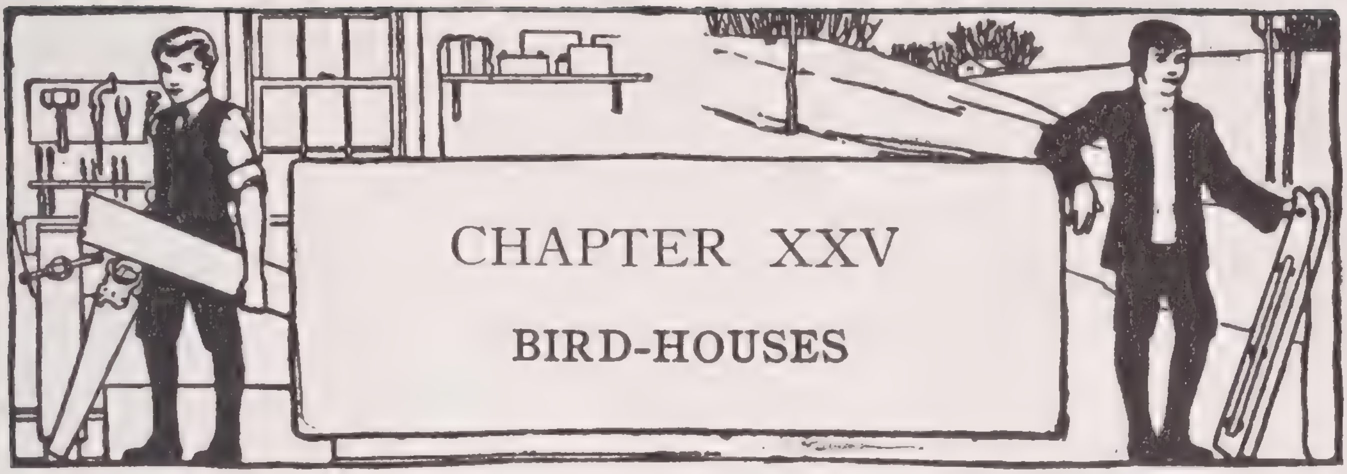

FIG. 475. — Bottom View of Wagon-bed.
FIGS. 476 and 477. — The Way to attach the Rear Axle.
FIGS. 478 and 479. — The Way to attach the Front Axle.

as shown, running a stove-bolt or screw through the holes (Figs. 477 and 478), and using either staples or nails bent over as additional fastenings (Figs. 476 to 478). Drive a metal pin through the outer hole in the axles to keep the hubs of the wheels from rubbing against the wood (Figs. 477 and 478).

**The Axle for the Front Wheels** is fastened to a wooden

axle (Fig. 478), which in turn is pivoted to the wagon-bed by means of a king-bolt as shown in Figs. 478 and 479. Bore a hole through the wagon-bed for the bolt, and put washers where shown before screwing the nut in place.

**Other Pushmobile Plans,** details of accessories, a diagram of a pushmobile race course, and suggestions for holding a race, are given in Chapters I, II and III of "Outdoor Boy Craftsmen," and in Chapters XXXIV, XXXV and XXXVI of "Big Book of Boys' Hobbies."



# CHAPTER XXV

## BIRD-HOUSES

WREN-HOUSES are in greatest demand, due partly to the fact that wren tenants are easily acquired, and partly to their small size, inexpensiveness, and simplicity of construction. Another feature in their favor

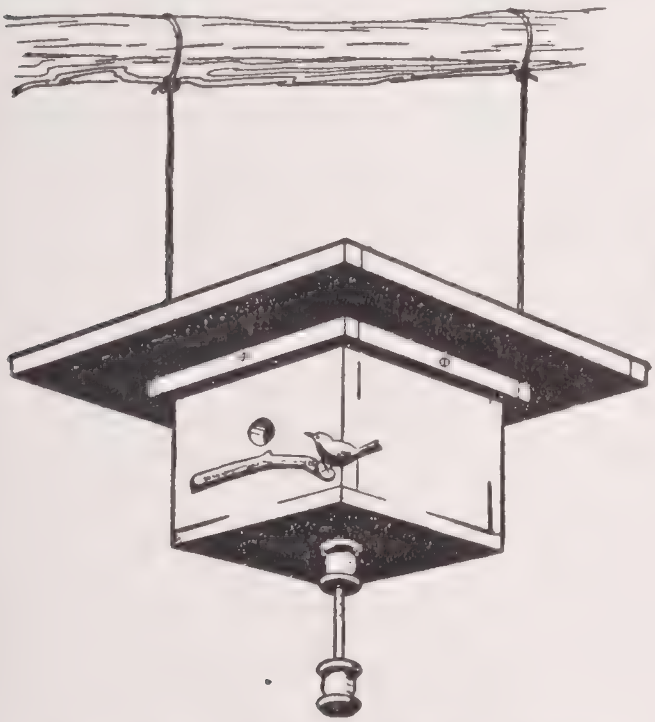


FIG. 480a. — A Box Wren-House.

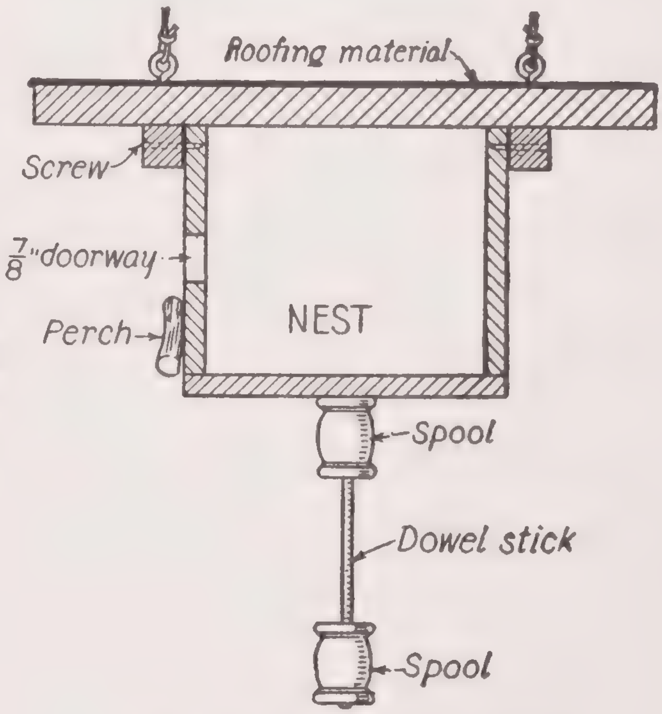



FIG. 480b. — Cross-Section.

is their small doorways, which are no larger than a silver quarter, and are too small for sparrows to enter. You will like

**The Box Wren-house** shown in Fig. 480a, and so will the first wrens to visit your yard this Spring.

The walls and floor are a box about 6 inches in each of its three dimensions (Figs. 480b and 481a). Cut down a larger box (Fig. 481b), or build a box, if necessary. Locate the center of one side, and bore a $\frac{7}{8}$-inch hole for a doorway (Fig. 481a).

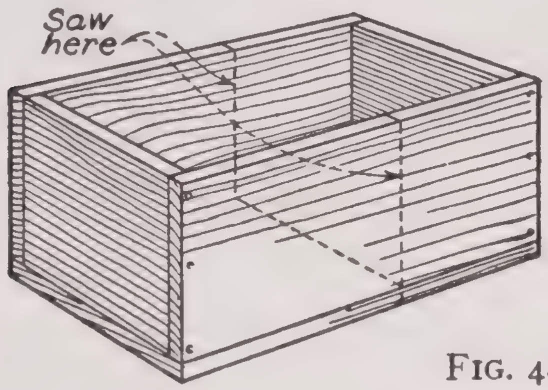



FIG. 481b.

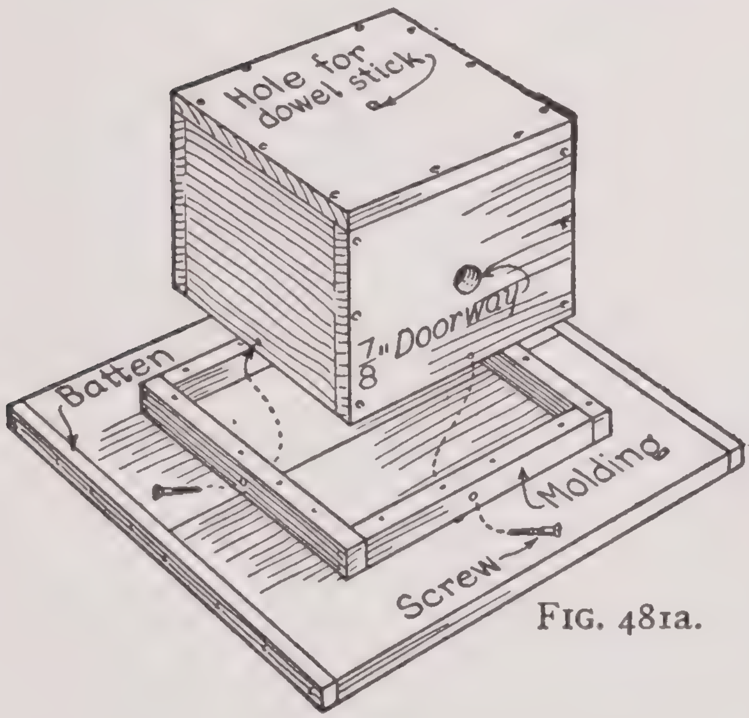



FIG. 481a.

FIG. 481a. — Detail of Box House.
FIG. 481b. — Cut down a Box this Way.

The roof requires a projection of 4 or 5 inches. Two or more boards $\frac{3}{4}$ inch thick will be needed. Fasten them together with end-battens, as shown in Fig. 481a. Then make a frame like that shown in Fig. 481a, of strips $\frac{3}{4}$ inch square, to form a molding or cornice, at the top of the walls. Leave enough clearance all around so that the roof can be removed easily for the annual house-cleaning. Bore a hole through the center of each strip, and drive screws through the holes into the house.

Cover the roof with slate-coated roofing-felt or shingles. Drive a pair of screw-eyes into the center of opposite sides of the roof, and fasten galvanized or copper wire to the screw-eyes for hangers.

Make the perch of two large spools and a piece of $\frac{1}{4}$-inch dowel-stick 9 inches long. Drive the dowel-stick through the spool holes, and fasten its upper end in a hole bored in the house bottom (Fig. 481a).

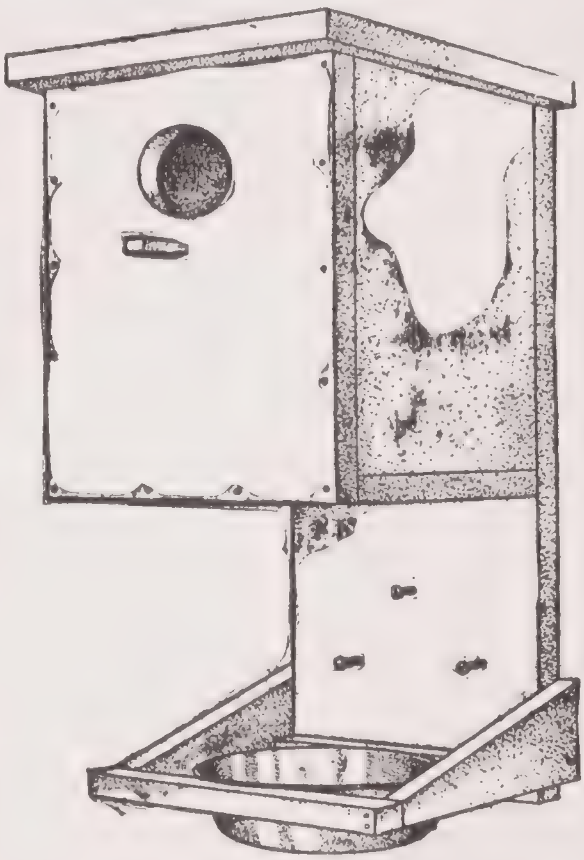


Fig. 482. — Another Box Bird-house with a Pan for Drinking Water.

**Another Box Bird-house** is shown in Fig. 482. This is similar to a house which the boys of some of the Chicago public schools have constructed and placed in the trees of the parks, with the addition of the pan bath. The illustration shows clearly how the back, sides, and roof are cut and fitted together, and how the water pan is bracketed out from the lower end of the back board, and I am going to let you work out the sizes for the various pieces according to what you think they ought to be.

The lower portion of the back board may be screwed or nailed to a wall or post, or if you omit the pan and place the box in a tree, it can be tied securely by running

a piece of clothes-line several times around it and the tree trunk.

A cheese-box cover and one of the small kegs in which mackerel and herring come to the market furnishes the materials for making

**A Bird Tower** such as is shown in Fig. 483. The keg must be thoroughly washed out with hot water and either washing soda or lye, and should be painted inside, to remove the fish odor. Bore four openings in the side of the keg, and fasten a perch stick in a small hole below each opening.

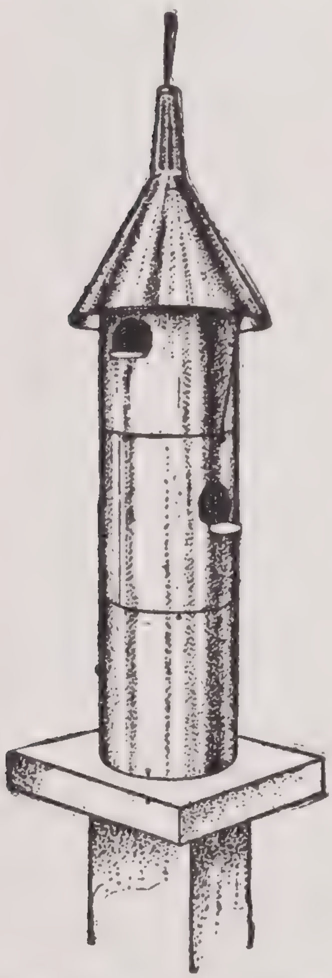


FIG. 487. — A Tin-can Bird Tower.

The illustration shows the keg mounted upon the end of a rug-pole, but if you cannot get one of these, the top of a clothes-post, or a piece of 2-by-4 set into the ground, will serve the purpose. Nail the keg to the support, then set the cheese-box cover on top and nail it in place.

The lower perches should run through the support as shown in the illustration, and may be of pieces of broken flagstaffs or cabinet-maker's dowel sticks.

**The Can Wren-tower** (Fig. 487) should be built for a shady part of the yard, because metal houses become very hot in the sun. Use one, two, or three tomato cans. Cut a hole $\frac{7}{8}$ inch in diameter in the side of each. Bend


Fig. 483. A Bird Tower.


Fig. 485. A Bird Ark.

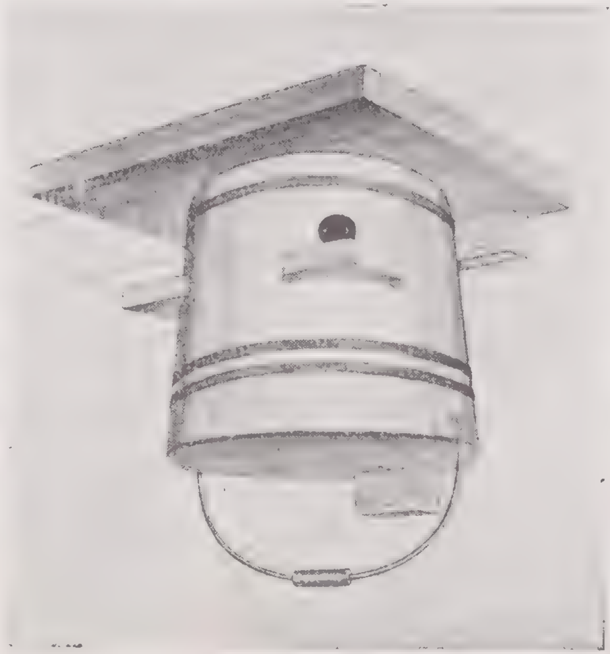
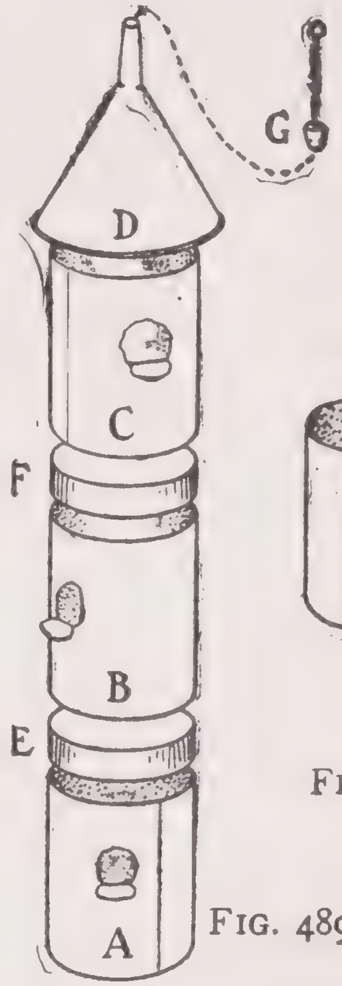


Fig. 486. A House and Swing.


Fig. 484. A Bird Castle.

the piece of tin out as shown in Fig. 488 to form a perch. Then remove the top of one can (*A*, Fig. 489), and the top and bottom of the other cans (*B* and *C*, Fig. 489). The best way to remove the ends is with a can-opener that cuts close to the edge and turns the cut edge down to form a smooth rim. The cans are joined together by means of two circular blocks of wood (*E* and *F*, Fig. 489), which also divide the tower into three compartments.



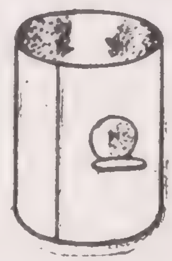



FIG. 488.

FIG. 489.

FIGS. 488 and 489.—Details of the Tin-can Bird Tower shown in Fig. 487.

A 6-inch tin funnel forms the roof (*D*, Fig. 489), and a cork with a piece of a hatpin stuck into it (*G*) fits into the spout of the funnel for a spire.

Tack the edges of the cans to the wooden blocks, and wire the funnel roof to the upper can as shown in Fig. 487, fastening one end of each wire to the funnel rim and the other end to a small staple driven into the upper block. Twist the wires until the funnel is firm. Nail the bottom can to the top of whatever support you provide for the tower. Paint the tin to prevent it from rusting.

**The Bird Castle** shown in Fig. 484 was designed and built by the author a few years ago for his garden. The

corner towers of this are built like the tower in Fig. 487. The castle measures 12 inches long, 7 inches wide, 16 inches high at the highest point, and 11 inches high at the lowest point, and is made out of box boards.

Figure 490 shows an end view of the castle with the tower of the opposite end in position. First cut the two end pieces *H*, and a third piece of the same shape and size for a center partition, then nail the front and back boards *I* and *J* to them. Cut the pieces indicated by the dotted lines *K* to fit between the center partition and the end pieces, for a loft floor. Cut an opening for each compartment in the end pieces (Fig. 490).

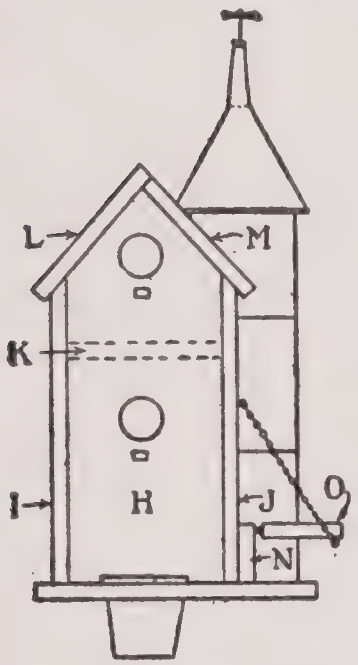


FIG. 490.—End View of Bird Castle shown in Fig. 484, with One Tower in Position.

Nail the roof boards *L* and *M* in place and fasten strip *N* to the base at the front (Fig. 490), then mount the castle upon a platform 11 inches wide and 24 inches long. Build up the towers at the two corners, and nail each can to the corner of the castle as you put it in place.

The drawbridge (*O*, Fig. 490) measures $2\frac{1}{2}$ inches by $3\frac{3}{4}$ inches; hinge one end to the base strip, and suspend the other end by small brass chains fastened to the under side and to the front wall.

Each can of the towers has a circular opening cut in it, but the long narrow windows in the towers and front wall

of the castle and the large doorway are painted. The walls should be painted white, and the roof green or red.

The little flag and the weather-vane are mounted upon nails stuck into corks, and the corks are pushed into the spouts of the funnels (Fig. 490). Set a cup in the platform, at each end, for drinking water. The castle may be bracketed upon a wall as shown in Fig. 484, or may be mounted upon a post.

**A Bird Ark**. For the bird ark shown in Fig. 485, three cans are joined together in the same manner as those of the towers are joined (Figs. 488 and 489). Both ends of the center can are removed, but the bottom is left on the end cans. Cut a $\frac{7}{8}$-inch hole in the side of the center can and a hole of the same diameter through the bottom of each end can; do not remove the pieces of tin from the openings, but bend them out for perches as shown. Cut the roof boards of the proper size to project over the ends and sides of the cans, nail them together, and then fasten them in place by driving nails through the boards into the connecting blocks between the cans.

Fasten the ark between blocks upon a board platform, then mount the platform upon a post support, and brace the supports with brackets to make it secure. Run several perch sticks through the brackets, as shown.

**A House and Swing** made out of a wooden pail inverted and bracketed to a wall as shown in Fig. 486, so that its handle hangs down and forms a swing, is an attractive little house for the back yard.

Make the vertical partition to divide the pail into two compartments, and cut a circular piece of board to fit in the top. Nail the roof board to the bottom of the pail, cut an opening into each compartment, and fit a small block of wood beneath each opening for a platform.

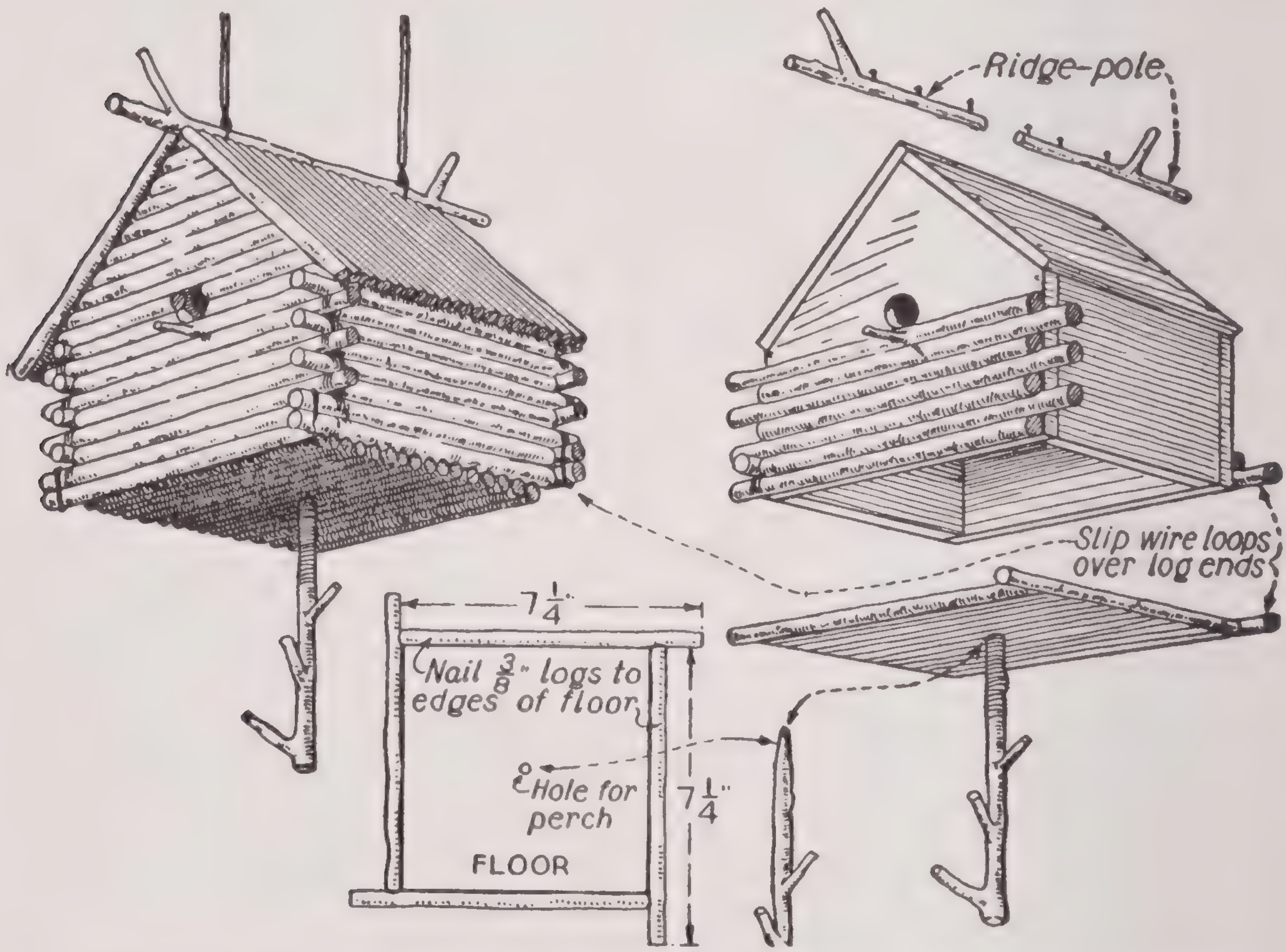



FIG. 491.—A Wren Log Cabin. FIG. 493.—Veneering the Inner Structure.
FIG. 492.—Floor Plan.

**A Wren Log Cabin.** Building rustic bird-houses is fun. Shrubbery cuttings do very well for logs, if of green wood. Dead wood breaks when you nail through it, rots quickly and falls to pieces. Young shoots from tree roots are good material. The author built the cabin shown in Fig. 491 of branches from a wild cherry tree.

The log veneering requires an inner structure of box boards like that shown in Figs. 493 and 494a, to support it. Build this of box boards $\frac{3}{8}$ inch thick.

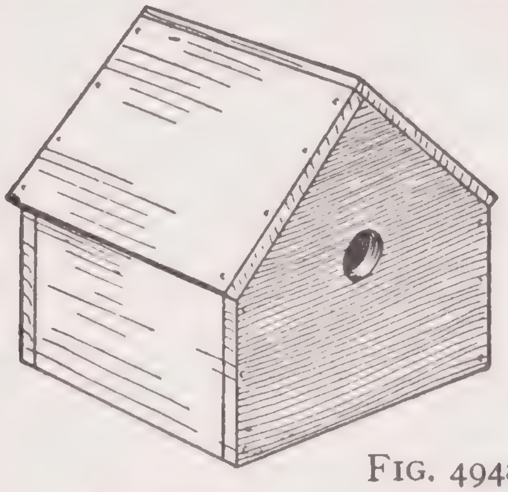


FIG. 494a.

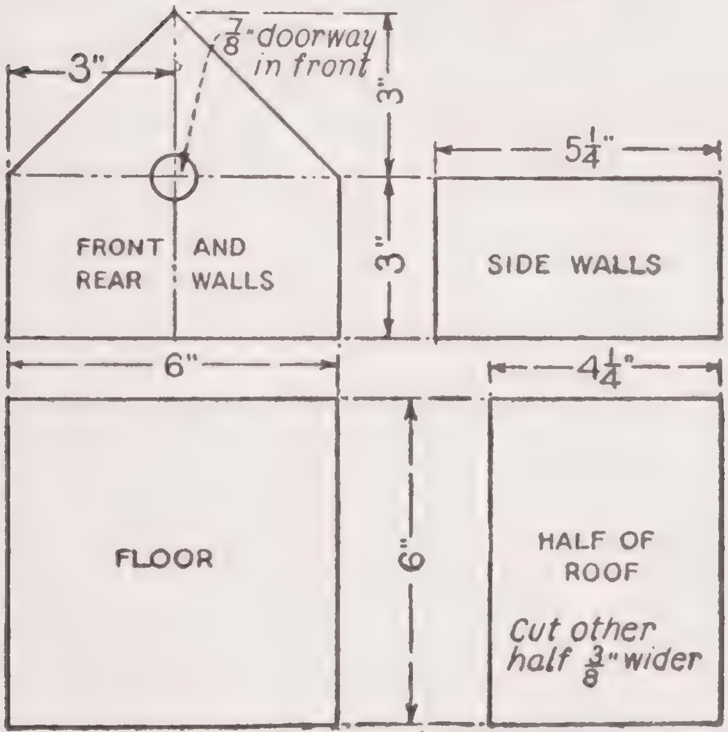



FIG. 494b.

FIG. 494a. — Build a Cabin of Box Boards.
FIG. 494b. — Patterns for Walls, Floor, and Roof

Figure 494b shows patterns for the parts. Cut two like pieces for the front and rear walls, two pieces for the side walls, a floor-board, and two roof-halves. Bore a $\frac{7}{8}$-inch doorway in the front wall where located on

the pattern. Notice that one roof-board is $\frac{3}{8}$ inch wider than the other, to allow for overlapping edges.

To assemble the inner structure, fasten the side walls between the front and rear walls with brads 1 inch long. Nail the roof-boards together and to the walls. The floor-board is removable for cleaning out old nests.

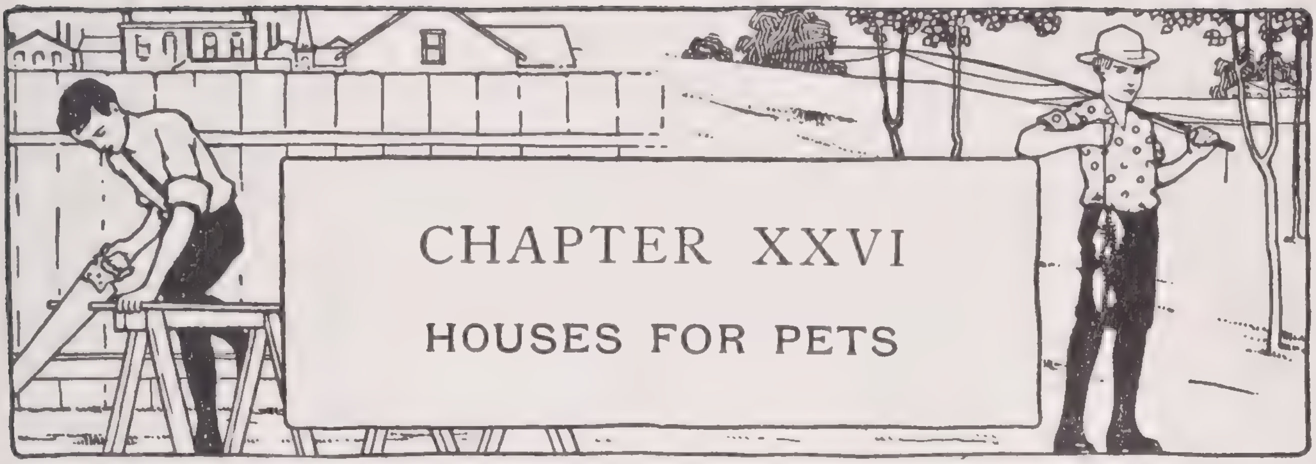
Figure 492 shows the length to cut the wall logs, and the way to fasten the first row of logs to the edge of the floor-board with only one end of each projecting. Cut the pieces with a coping-saw or other small saw.

When you have nailed the first row of logs to the edge of the floor-board, as shown in Figs. 492 and 493, lay up the wall logs. Cut a log with a crotch at its center, to fit below the doorway, (Fig. 493) to form an entrance perch. Nail the logs with $\frac{3}{4}$-inch brads. Cut shorter logs to fit the triangular gable ends.

Cut the roof logs $5\frac{1}{2}$ inches long, and nail them so that they overhang the side walls. Finish the gable ends by nailing logs to the roof edges as shown in Fig. 491. These gable logs will form a slight overhang. Cut two pieces of branches, each with a crotch, and nail them to the roof ridge for a ridge-pole.

Complete the cabin floor by driving a crotched branch, like that in the detail, into a hole bored through the center of the floor-board (Figs. 492 and 493). Then cover the under surface with log veneering, as shown.

Attach the floor to the cabin by forming wire loops to fit over the projecting ends of the first tiers of logs.



# CHAPTER XXVI

## HOUSES FOR PETS

ALTHOUGH a city boy doesn't have the opportunity enjoyed by his country cousin, to keep pets, he generally manages to own a dog, unless he lives in a restricted apartment building, and probably he has space in a yard or garage where he can keep a few pets such as rabbits, white rats, fancy mice and pigeons.

The size of a dog-house depends upon the size of the dog, so get your dog and see what he looks like before you build his kennel; but if you get a pup of a large breed, be sure to make the house plenty large enough to allow for his growth, otherwise you will soon have to remodel the house or trade the dog for one that will fit.

**A Dog-house** may be constructed out of packing-boxes or may be built up of any boards you can find about the place. Figure 495 shows a well-planned house of medium size, with a feature which is too frequently omitted in building one — provision for ventilation. If the house is set directly upon the ground, the floor is usually damp, for there is little or no chance for it to dry out after a rain, but by raising it a few inches as

shown in the illustration by mounting it upon a base, and boring a number of holes through the base, the floor

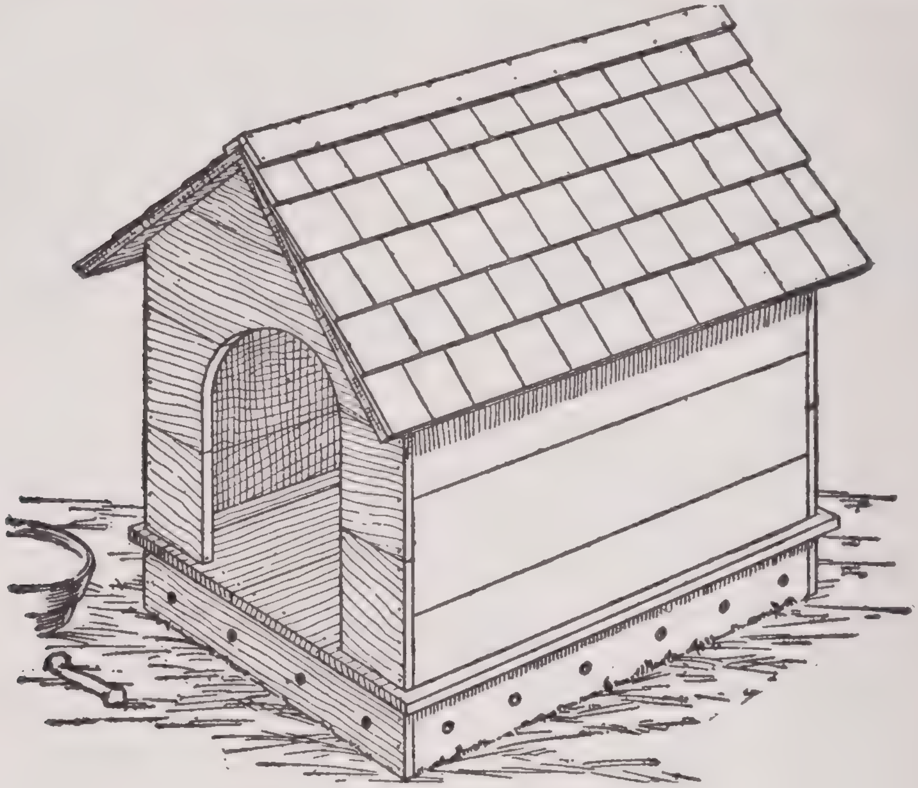


FIG. 495. — A Dog-house.

(See working-drawings on page 89.)

never comes in contact with the ground, and a constant circulation of air, which will pass in and out of the holes, will keep the ground underneath dry.

Figure 92 on page 89 shows complete working-drawings for this dog-house, it having been taken for an example in explaining the proper method for laying out a sheet of working details. Of course you may alter the dimensions on the drawings to suit your needs.

First construct a frame for the base of the house, then cut the floor boards of the proper size and nail them to the top edge of the base. Next construct the four walls in sections, making the two sides alike

and the front and rear wall alike, and fastening the boards together with battens as shown on the working-drawings. Mark out the arched opening on the front wall, and nail a batten across the boards each side of it, as shown, to hold together the ends of the boards which are to be cut. When the sections have been prepared, fasten their ends together and toe-nail their bottom edges to the floor of the base.

The roof may be made of boards alone, or of boards covered with shingles, tin, or some form of composition roofing-paper. If you shingle the roof, lay the boards lengthwise of the house, as shown on the working-drawings; then lay the shingles on in the same way that they are put on any roof, starting at the eaves and laying each succeeding row with 4 or 5 inches of the shingles exposed to the weather. The shingles may be split up into narrow pieces, and the lap may be increased so as to leave 2 or 3 inches exposed, if you want to make them of smaller proportions. Nail a ridge-board along each side of the roof at the peak, to cover the ends of the shingles and make the roof tight at that point.

The dog-house should be given two coats of paint and be repainted once a year to keep it in condition.

**The Rabbit-hutch** shown in Figs. 496 and 497 may be constructed out of a box or built out of new boards, whichever is the more easily obtained. The box should be about 4 feet long, 14 inches wide, and 20 inches deep.

If you make this box, first prepare the end pieces, then cut the side boards and nail them to the ends, and then

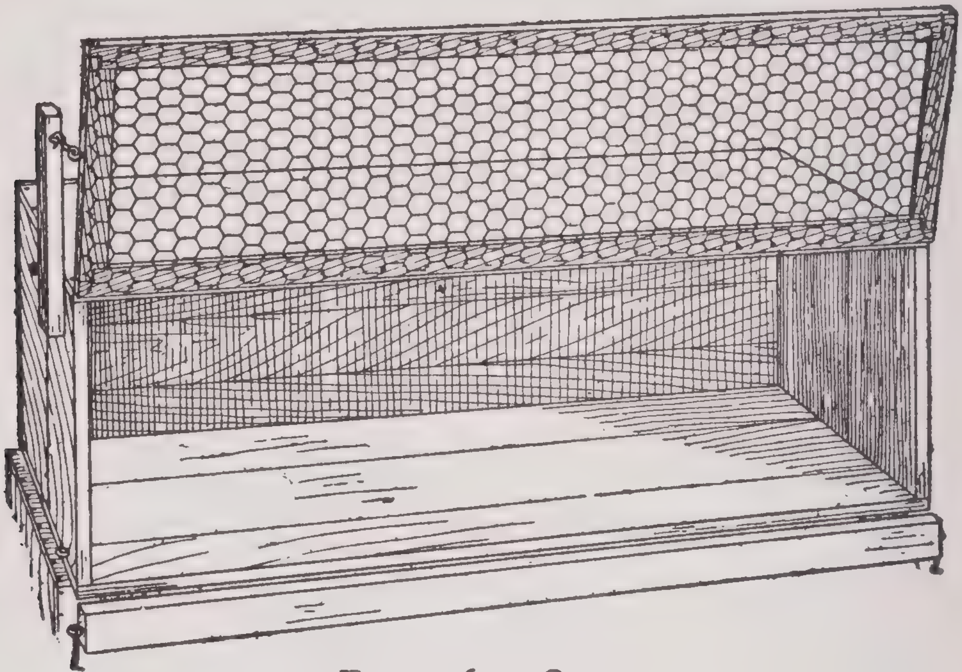


FIG. 496. — Open.

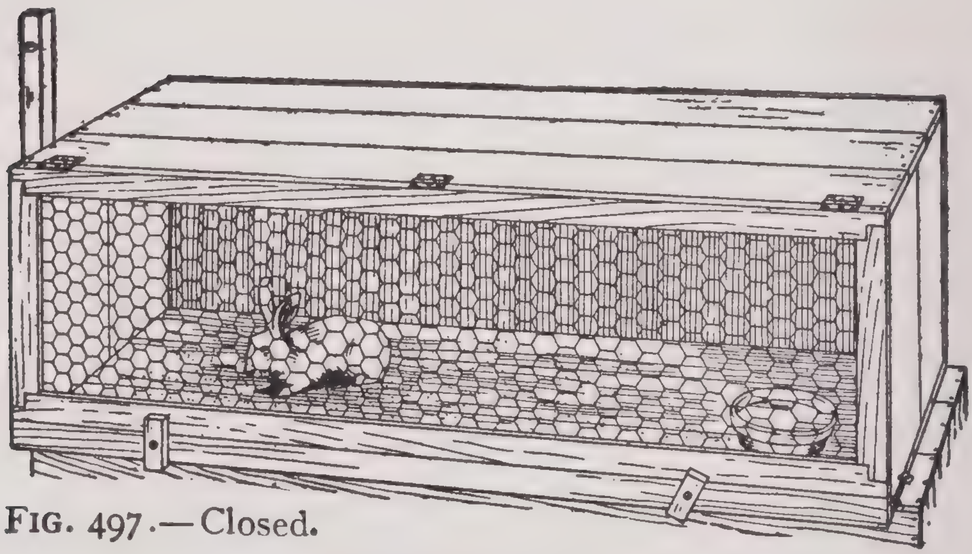


FIG. 497.—Closed.

FIGS. 496 and 497. — A Rabbit-hutch.

cut the bottom boards and nail them to the edges of the end and side boards. As shown in the illustration, the box is turned upon its side so the top will form the front of the hutch.

The front is covered with wire netting tacked to a frame, and the frame is hinged in place so that it will also form a door. Make the frame equal to the length of the box and in width about 2 inches less than the width of the box; use strips about 2 inches wide and 1 inch thick. The ends of the strips may be notched and fitted together as shown, or they may be butted, nailed and reënforced with corrugated fasteners.

**Galvanized Poultry-netting** is the material probably easiest for most boys to procure for covering the open front of the hutch. This is made in widths ranging from 12 inches to 72 inches, and can be had in 1-inch, $1\frac{1}{2}$-inch, and 2-inch mesh (the meshes are the openings formed by the crossed wires). The large mesh is plenty small enough for large rabbits, but the 1-inch size is best for breeding hutches, as the little fellows can crawl through larger openings. Poultry-netting has an hexagonal-shaped mesh.

**Twist Wire Cloth** is another form of covering which is very good for the purpose. Its meshes are somewhat similar to those of poultry netting, but are 1 inch long and $\frac{1}{2}$ inch wide.

**Wire Cloth** has a square mesh like the wire used for door and window screens. The heavier grades are suitable for rabbit-hutches and are often used.

Buy small *netting staples* with which to put on the wire netting or cloth.

After covering the frame with the netting or cloth,

hinge it to the top edge of the hutch with three 2-by-2-inch steel butts. Then cut a strip of just the length of the box and 2 inches wide, and hinge it to the bottom directly below the frame with a pair of 2-by-2-inch butts. Screw a hook into each end of the strip, and fasten a screw-eye or nail into each end of the box in the proper place for the hook to catch on to. Cut a couple of wooden buttons, bore a hole through the center of each large enough for a screw to slip through, and screw them to the bottom hinge-strip about 12 inches from the ends for button catches to hold the wire frame closed (Fig. 497). The hinge-strip is provided to keep the sawdust, or other floor covering, from dropping out of the hutch every time the front is opened, and it is hinged in place so it may be dropped as shown in Fig. 496 when cleaning out the hutch, to make easier the work of removing the old sawdust. To hold open the front while cleaning, nail a strip of wood to one end of the hutch, and fasten a hook in the edge of the frame and a screw-eye in the proper position in the stick for it to hook into, as shown in Fig. 496.

The hutch should set up on something high enough to keep it at least 18 inches above the ground or floor, as rabbits are very sensitive to dampness. Brackets may be fastened to a wall at the proper height, or the hutch may be placed upon an overturned packing-box.

If you intend to raise rabbits, you should have

**A Breeding Hutch**, in addition to this hutch which will

then be used to keep the male rabbit in after the baby rabbits have arrived. The breeding hutch may be constructed out of a box of the same size as that used for the hutch just described, but one end must be partitioned off for a nest, and a doorway 5 inches wide and 6 inches high must be cut through the partition to connect it with the main runway of the hutch. The nest must be kept dark, so, instead of running the wire front along the full length, it must be stopped off upon a line with the partition. In place of the wire, hinge a board over this portion. This provides a doorway by which the nest can be reached from the outside.

**The Two-story Rabbit-hutch** shown in Fig. 498 is made

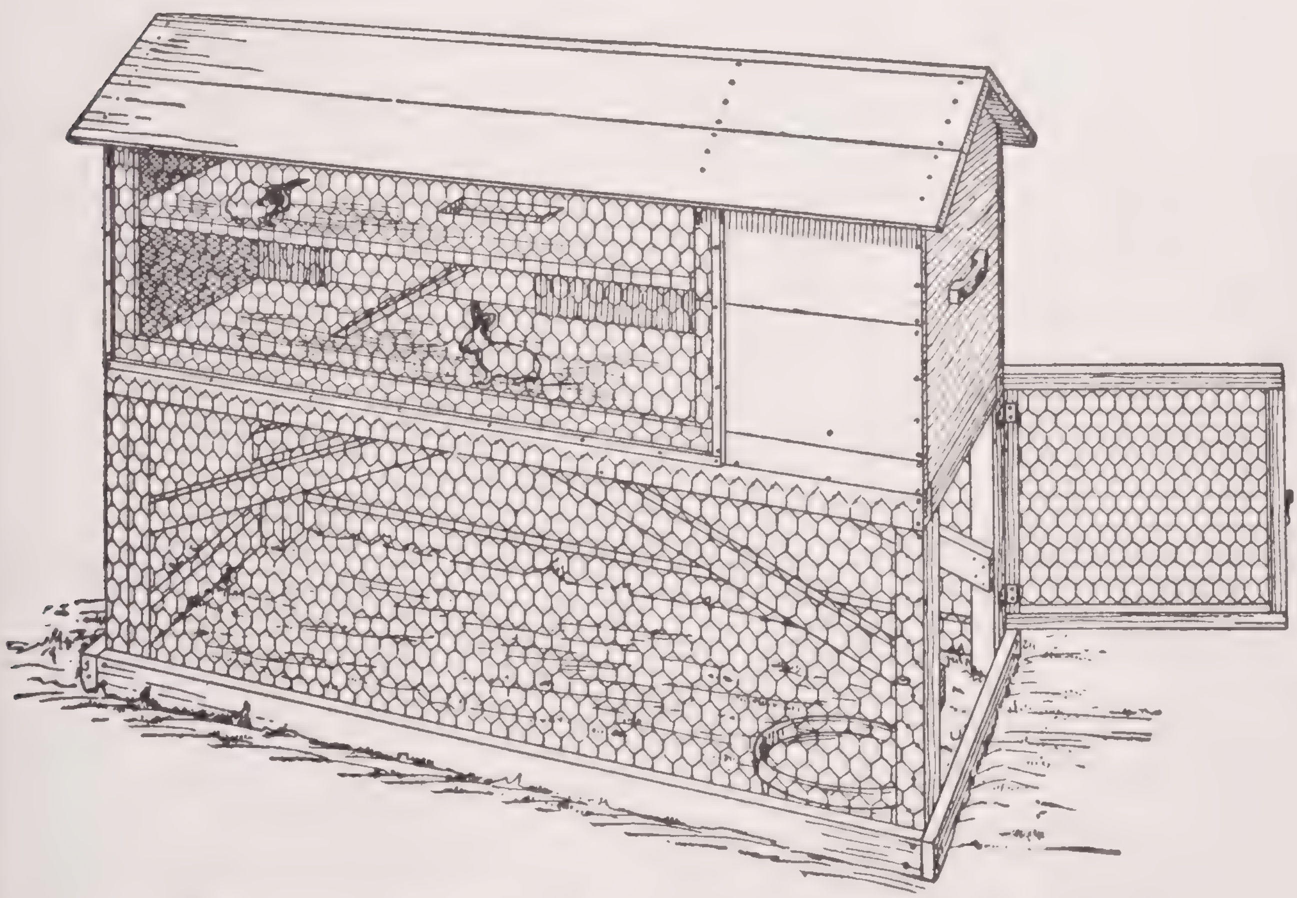


FIG. 498. — A Two-story Rabbit-hutch with Yard Beneath.

portable so it may be taken to a place of shelter during severe weather, and is provided with a handle at either end for convenience in carrying. Then by stretching wire netting or wire cloth around the supports, which should be 18 inches or more high, a good playground is provided in which your "bunnies" can be allowed to run about for a while each day. This yard is also a convenient place to put them in while you clean out the hutch.

If you can find a packing-box 18 inches deep, 18 or 20 inches wide, and 4 feet long, use that for the hutch. Remove the boards from one side of the box (which will be the front of the hutch), then rip up two of the boards removed, into pieces 3 or 4 inches wide, and nail these to the front, one at the top of the box (*A*, Fig. 499) and

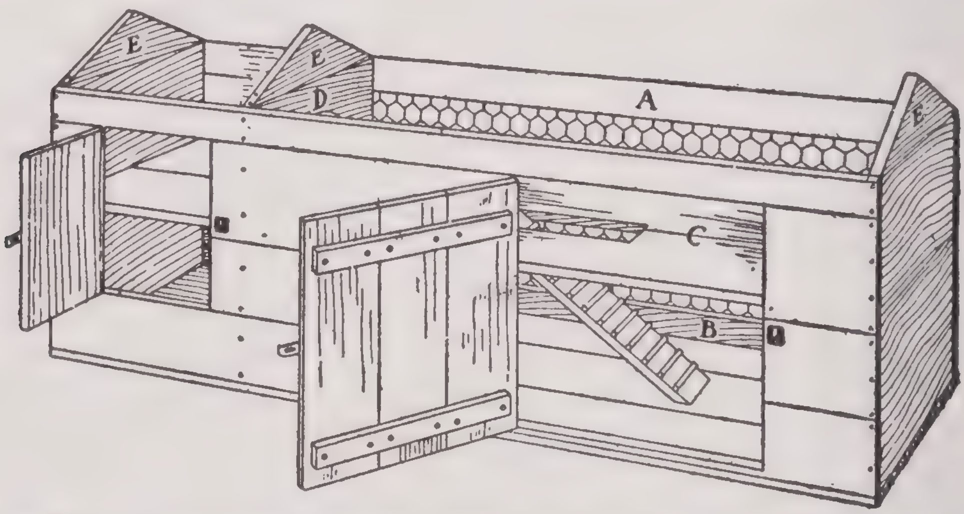



FIG. 499. — The Two-story Rabbit-hutch before the Roof has been put On.

the other at the bottom *B*. Upon the inside of the back boards, mark out a 14-inch square feed and clean-out door 6 inches from one end, and a 6-by-10-inch doorway to the compartments 3 inches from the other end. Before cutting out these openings, nail a vertical batten

across the boards each side of the lines to hold the cut ends together.

Cut enough boards of the proper length to make the second-story floor, batten them together upon the under side, and cut a 5-by-10-inch stairway opening about 18 inches from one end, and in the center of the width of the floor; fasten this to the ends and back of the box midway between the top and bottom (*C*, Fig. 499). Then prepare two partitions with an arched doorway about 5 inches wide and 6 inches high cut in each, and fasten one in each story 12 inches away from the compartment end of the hutch (Fig. 499). Cut three triangular pieces and nail one to the top of each end piece of the hutch for gable-ends, and one to the top of partition *D* (*E*, Fig. 499).

Cut a piece of board 5 inches wide and about 18 inches long for stairs, and tack a number of small cross-pieces to it to keep the rabbits from slipping while running up and down. Hinge the stairs to the second floor with a small hinge, or a piece of leather, and leave the lower end loose so it may be raised up out of the way every time you clean out the first story.

Board up the front of the compartments (Fig. 498), and nail a vertical strip of the same width as the top rail *A* and the bottom rail *B* (Fig. 499) to the opposite end of the hutch. Cover the remainder of the front with wire netting or cloth, and tack wooden strips over the edges of the wire to conceal the rough ends (Fig. 498).

Make the door to the compartments out of a single board, and the feed door out of several pieces battened together. Hinge the doors in place, and provide them with hasps and padlocks, if there is any danger of curious ones opening the hutch while you are away. Leather strips may be substituted for iron hinges, and wooden buttons or hooks may be used in place of hasps, if the hutch does not require a padlock.

For breeding purposes the stairway may be omitted; then the doe and her young can be kept by themselves in one story; but it is better to build separate one-story breeding hutches.

**The Rabbit Yard.** As you must know, if you have had any experience with raising them, rabbits are great burrowers and will dig under the walls of any inclosure you can build for them, unless you provide a floor or carry the walls down below their reach. The best method for keeping them within a small yard is to extend the wire netting with which you cover the framework about 18 inches below the surface of the ground. After laying out the lines of the framework of the yard, dig a trench on all four sides to the required depth, then set up the four corner posts, which should be long enough to stand at least 18 inches above the ground, and nail on the top pieces, the baseboards, and the side braces. Then stretch the wire around the framework and tack it in place; at the gate end cut the wire off at grade and fasten it to the baseboard. Construct the gate as shown, cover it on the

outside with netting, hinge it to one of the corner posts, and provide it with a hook.

If the ground where you build the yard is bare, dig up some sod and plant it inside of the inclosure, so your rabbits will have grass to play in.

The raising of white rats and fancy mice is a profitable business for boys, and it requires very little time and an expenditure of only a dollar for a pair to start with.

**A Cage for White Rats** or fancy mice should be constructed out of a box about 14 inches deep, 14 inches

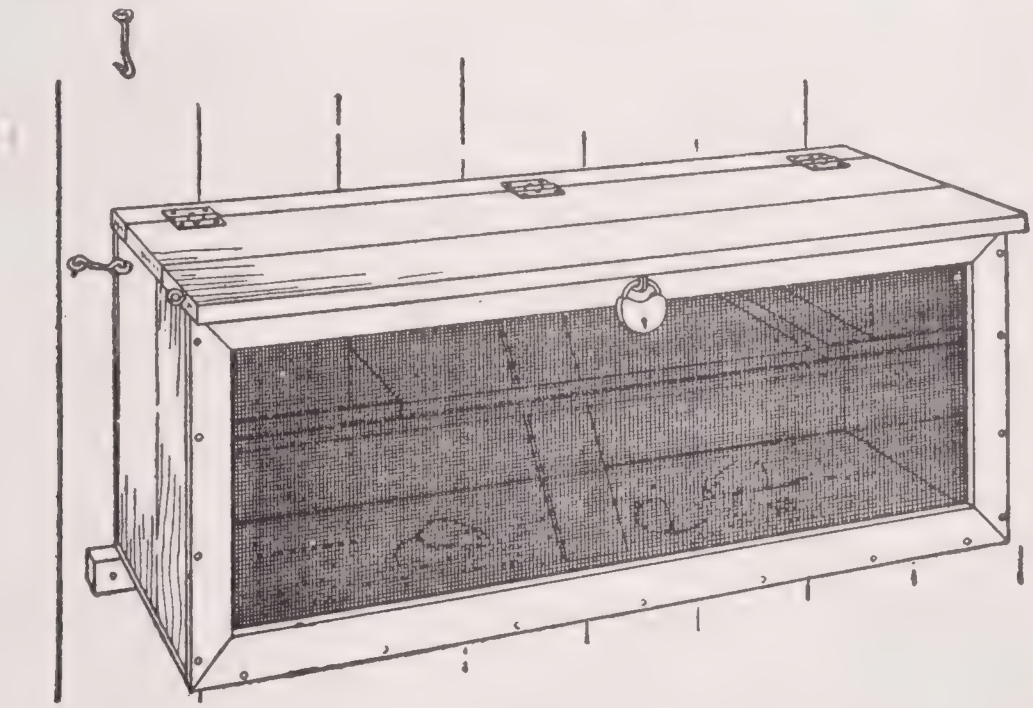


FIG. 500. — Cage for White Rats.

wide, and 3 feet long. A good form of cage is shown in Fig. 500. Remove one side of the box you have procured (this side of the box will be the front of the cage) (Fig. 501), then cut two strips 3 inches wide by the length of the box inside, and fasten them midway between the

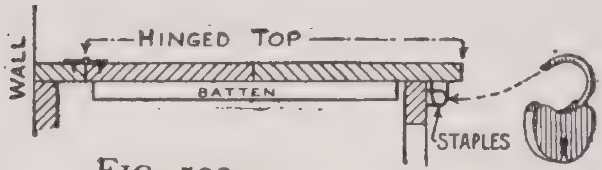



FIG. 502.

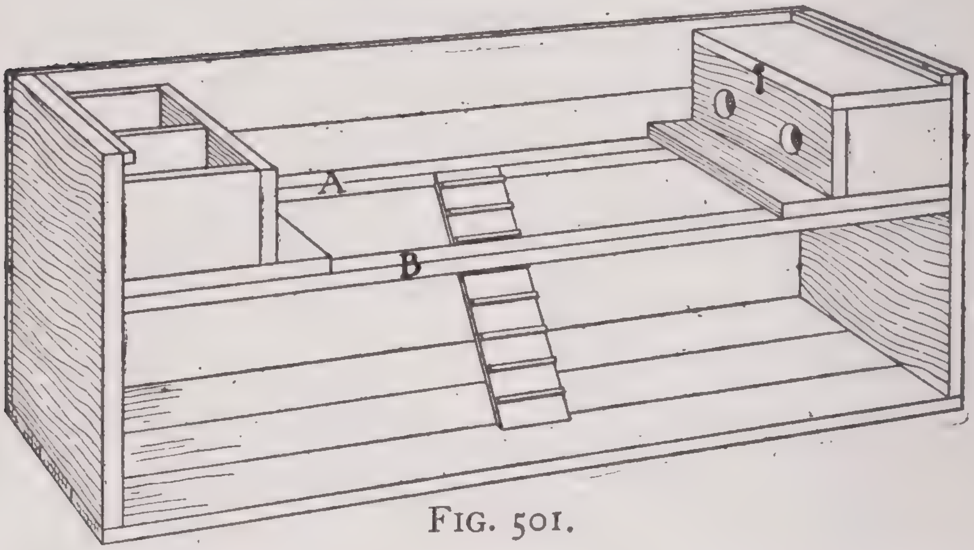



FIG. 501.

FIG. 501. — View of Inside of White Rat Cage showing Arrangement of Nest Boxes and Stairs.
FIG. 502. — Section through the Hinged Top.

top and bottom of the box, one along the back and the other along the front.

**Make a Couple of Nest Boxes** as shown in Fig. 503, as long as the cage is wide, 5 inches wide (inside), and 4 inches deep (inside); divide them into two compartments each as shown, and cut a doorway $1\frac{1}{2}$ inches in diameter into each compartment. Cut a board to fit the top of each box for a cover, and bend a piece of wire into the shape of a hook (Fig. 503) and fasten it in the proper

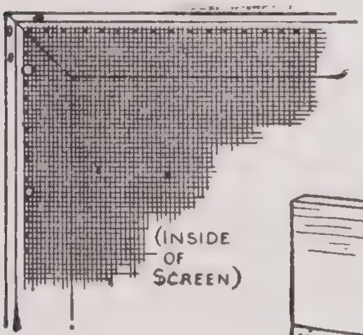



FIG. 504.

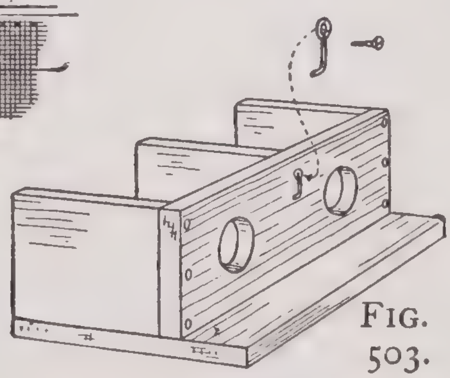


FIG. 503.

FIG. 503. — Nest Box for White Rat Cage.
FIG. 504. — Corner of Front Screen showing Frame and Attachment of Wire.

position to hook on to a short nail or screw driven into the edge of the cover (Fig. 501). Fasten the nest boxes on top of strips *A* and *B*, and tack a strip to each end of the cage just above the nest box cover to hold down the back edge (Fig. 501). When the cover is unhooked, it can be slipped from under this strip and removed.

Make the stairs out of a piece of board 3 inches wide, tack cross-pieces to it about 1½ inches apart, and fasten it to strip *A* and to the floor, in the center of the cage.

Strips *A* and *B*, together with the platforms in front of the nest boxes, furnish

**An Elevated "Race-track"** which your rats or mice will make good use of, especially the frisky young ones who love to chase one another about as well as any children do.

Galvanized screen wire cloth is the most satisfactory covering for the front of the cage, and the best method of putting this on is by making a wooden frame out of strips 3 inches wide, with the corners mitered and nailed together (Fig. 504), and tacking the wire to the inside face of this. The frame can be nailed or screwed to the cage (Fig. 500). This is a better method than that of tacking the wire over the edges of the box, as the wire can be stretched tighter and looks neater, and, what is more important, it prevents the wire from bulging out between the tacks and providing the rats with a chance to gnaw away the edge of the box at those points until the space is big enough to escape through.

The top of the cage should project about ½ inch over

the ends and 2 inches over the front. First nail a hinge-strip across the top at the back, then batten together the remaining boards, and hinge them to this strip (Fig. 502). By driving a staple into the under side of the cover and another into the screen frame, so the two will come together side by side when the top is closed (Fig. 502), the cage may be padlocked.

**Paint your Hutches and Cages** on the outside, and whitewash them on the inside.

**Floor Covering.** Cover the floors with a thick layer of sawdust, which you can get from a planing-mill; clean out the hutches and cages twice a week, and replace the old sawdust with fresh, so as to keep conditions sanitary.

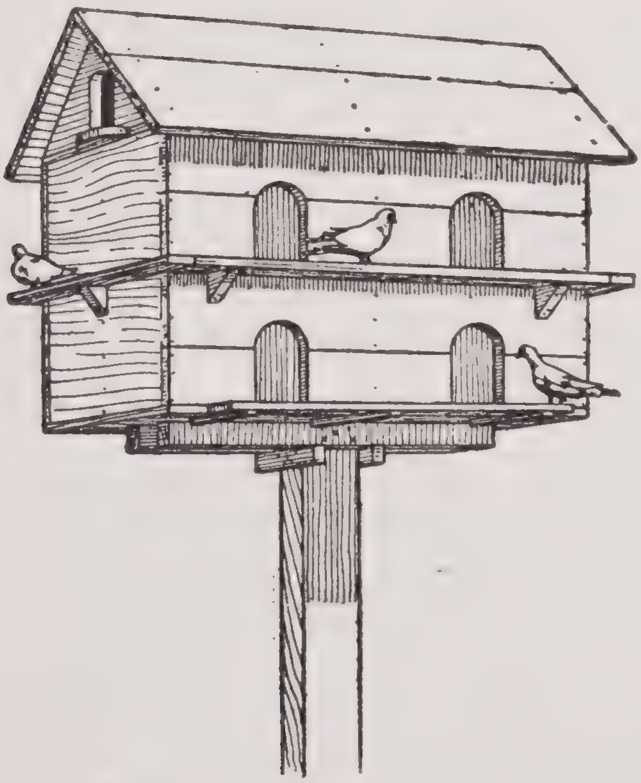


FIG. 505. — A Pigeon-cote.

Place hay in the breeding compartments for the nests.

**Drinking Receptacles.** Get a small earthenware dish for drinking water. This will stand solidly upon the floor and not be so likely to overturn as a cup, bowl, or other receptacle with a small base. Use a very shallow dish for the rat-cage.

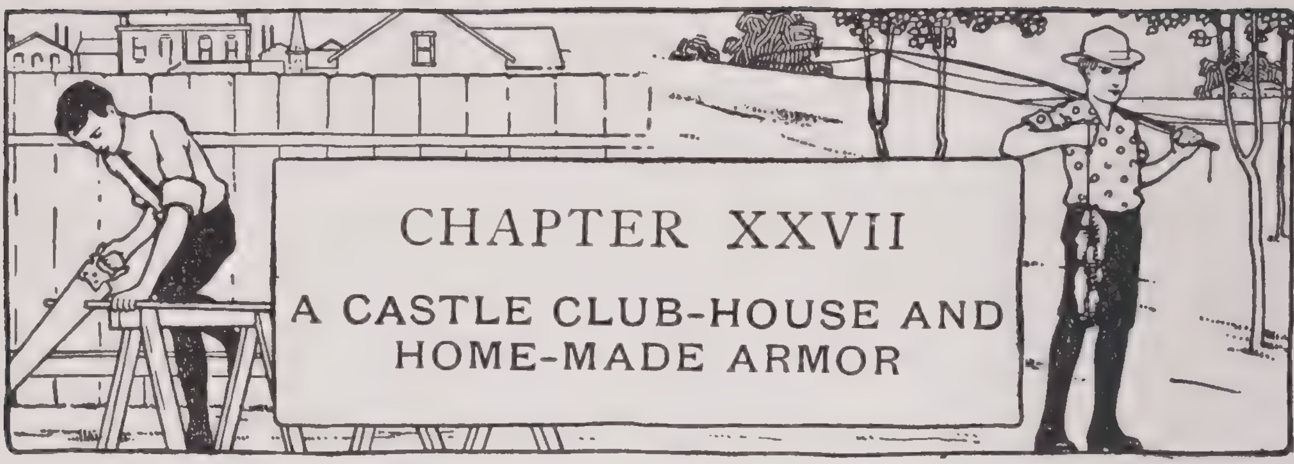
**A Pigeon-cote** like the one shown in Fig. 505 may be made out of a packing-box. Divide it into two stories, by fastening a floor

midway between the bottom and top, and divide each story into two compartments. Nail the cover boards to the box, fasten a triangular piece to the top edge of each end to form the gables, and then cut and nail the roof boards in place. The space between the box cover and the roof may be divided into two compartments by fastening a triangular piece similar to the gable-ends to the cover boards, before nailing on the roof.

Cut openings through the gable-ends and the sides of the box, into the compartments, and fasten perches below them.

The pigeon-cote may be bracketed to a wall or supported upon a post.

**Other Plans for Pet-shelters** will be found in Chapters VII and IX of "Outdoor Boy Craftsmen," and Chapters XXV, XXVI and XXVII of "Big Book of Boys' Hobbies."



# CHAPTER XXVII

## A CASTLE CLUB-HOUSE AND HOME-MADE ARMOR

THE castle club-house shown in Fig. 506 is an idea which the author has been holding in reserve for you for a good many years, for he originated it and carried it out on similar lines in his city back yard when a lad. The work is not difficult, and the plan may be simplified or enlarged upon according to how much time you care to spend upon it. A boy's interest in a thing often ceases the moment it is perfected to the point where further improvement is impossible, therefore any piece of work which will suggest alterations and additions from time to time is more acceptable than one which does not. It can be said for the castle club-house that there are many schemes besides those described in this chapter which may be developed by the builders, and which will probably suggest themselves.

**Material.** As the castle may be built in the corner of the back yard, the material for two walls may be saved, and the lumber required for the rest of the building will cost very little, as you will see by looking at the illustrations. The framework, with the exception of the corner

post, is built of boards, the corner turrets of barrels, and the sides of box boards and scraps of all sorts of lengths and widths. Second-hand lumber can generally be bought very cheap wherever a frame building is being torn down or remodeled, and this will answer the purpose as well as new material.

Before starting work it is best to do a little figuring on just what you will need, and then sort out all of the boards you have succeeded in getting and see if you will have enough; if you find that you will not, and there is no possibility of procuring more, it will then be an easy matter to cut down the dimensions of the castle so that you will be able to complete the job.

**The Framework.** Mark out the dimensions upon the ground and lay a board along the end and side for plates upon which to rest the wall framework (*A* and *B*, Fig. 507). Then take a 6-foot piece of 4-by-4-inch stuff, or two pieces of 2-by-4-inch stuff spiked together, and stand it upon the plates at the corner for a corner post *C*, and brace it temporarily. Cut uprights *D* and *E* to fit between the fence rails, if the rails happen to be upon the inside face of the fence, and nail them to the fence directly in line with the corner post. Next, cut the horizontal boards *F*, *G*, *H*, and *I*, and nail them to the corner post *C* and the fence uprights *D* and *E*, placing *F* and *G* about 8 inches above the ground-plates, and *H* and *I* even with the tops of *C*, *D*, and *E*. Boards *J* and *K* will be necessary only in case boards *H* and *I* extend

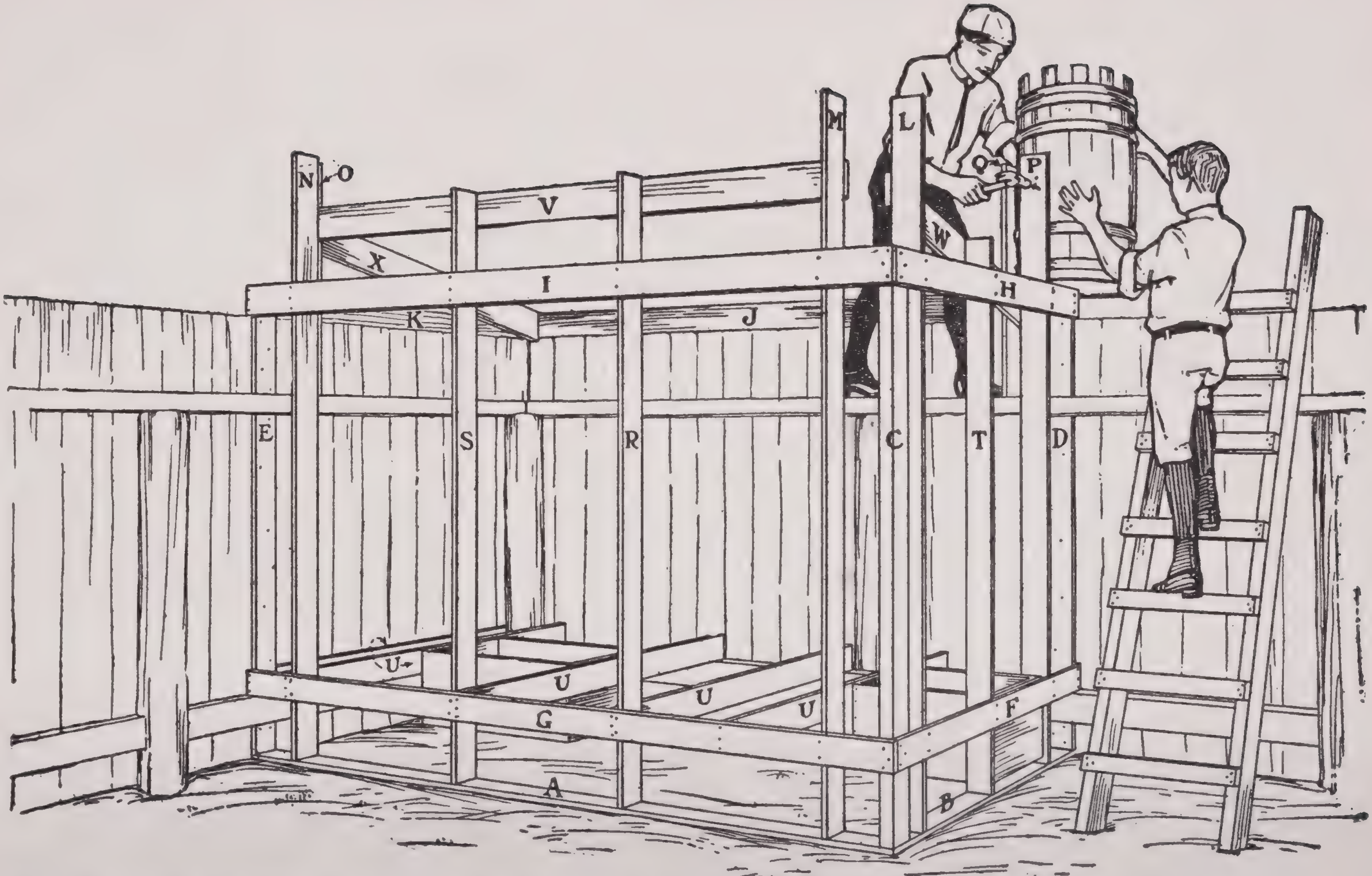



FIG. 507. — The Framework of the Castle, showing how it is built of boards, how the barrel turrets are fastened in place, and how boxes are fastened between the joists for the treasure vaults.

Fig. 506. The Castle Club House.

FIG. 515. A BOY KNIGHT WITH HIS HOME-MADE ARMOR.

above the top of the fence, as in Fig. 507. Cut uprights *L*, *M*, *N*, *O*, *P*, and *Q* 7 feet 6 inches long, and nail them to plates *A* and *B*, and to horizontal pieces *F*, *G*, *H*, and *I*, 11 inches in from the corners formed by boards *H*, *I*, *J*, and *K*. Cut uprights *R* and *S* 7 feet long, and fasten them in the center of the front wall 2 feet apart for the entrance jambs, and set upright *T* in the center of the end wall for an intermediate support.

**The Floor Joists**, marked *U* in Fig. 507, are 4-inch boards placed on edge, and are fitted between the fence and horizontal piece *G*. If there isn't a rail on the inside face of the fence at the proper height to rest the ends of the joists on, nail a horizontal piece to the fence for the purpose.

Before putting on the wall siding, get three barrels for **The Corner Turrets**. Be sure that no hoops are missing from these, and nail each stave to each hoop to keep the barrels from falling apart. Cut a number of pieces of tin about 3 by 5 inches in size, and tack them to the inside edge of the tops of the barrels, about 3 inches apart (Fig. 509), to form the battlements; then set the barrels on boards *H*, *I*, *J*, and *K*, between uprights *L*, *M*, *N*, *O*, *P*, and *Q*, and nail them to these uprights (Fig. 507).

**Board up the Walls** regardless of the openings, with the exception of the entrance, around which the boards may be fitted, and cut the openings afterwards. Cut the boards so that each end will strike the center of an upright, and use up the short pieces wherever it is possible

to do so, in order to save the long pieces for places requiring them. When you are ready

**To cut the Openings**, mark them out upon the walls and, about $\frac{1}{2}$ inch outside of the lines, nail a vertical strip across the boards which are to be cut to hold them together (Fig. 511). The upper row of openings on the main walls, and those in the turrets, are painted on the wood.

**The Roof**. To support the upper end of the roof boarding, it will be necessary to nail the horizontal piece *V* to

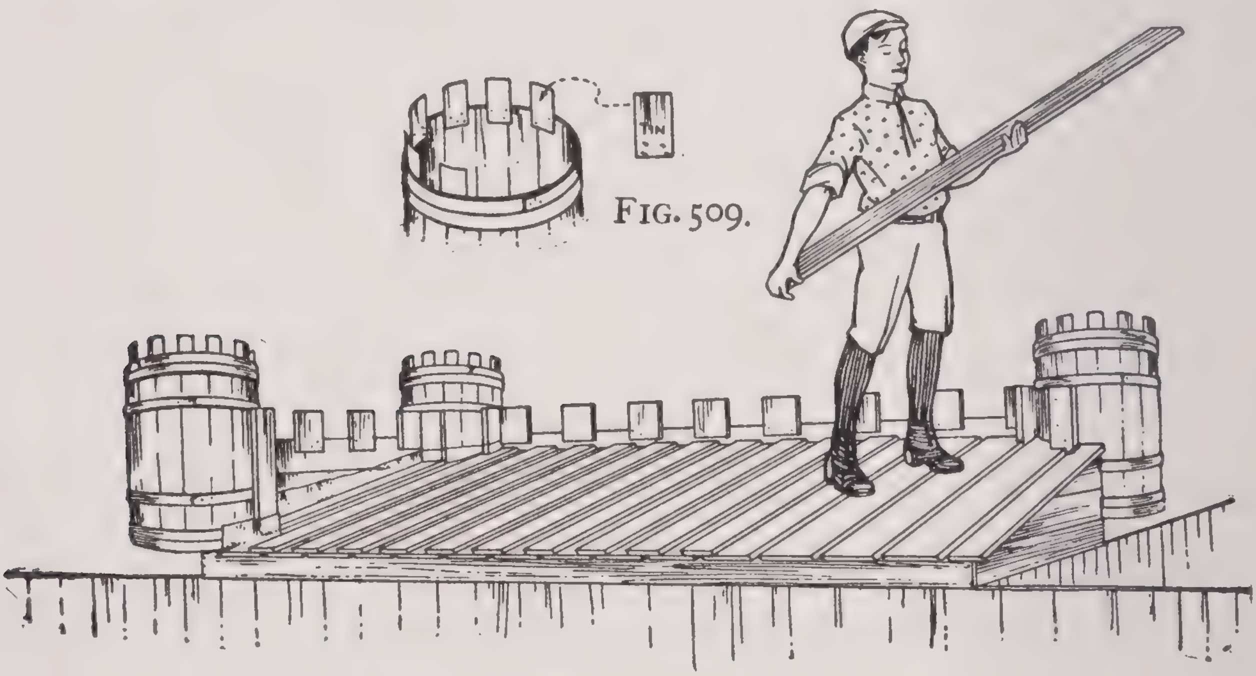


FIG. 509.

FIG. 508.

FIG. 508. — How the Roof should be put On.
FIG. 509. — Construction of the Turret Battlements.

uprights *M*, *R*, *S*, and *N*, even with the tops of *R* and *S*; at the sides you will have to fasten the diagonal pieces *W* and *X*; and around the barrels extra blocking will be required. Figure 508 shows how the roof boarding should be laid. First place one layer of boards about 1

inch apart, as shown, then cover the spaces between with another layer. The best way to make water-tight joinings around the barrels and walls is to get some tar paper and tack a strip of it to the roof along the walls, lap it up on to the walls and barrels, and daub it with tar. But if you cannot get the roofing-paper and tar, stuff all the cracks with newspaper, using a pointed stick with which to push the paper in, and then tack pieces of tin over them and lap them up on to the walls and barrels.

**If the Roof leaks** a little after you have finished it, do not worry; the castle will dry out quickly after a storm, inasmuch as the floor is high off the ground with plenty of space beneath for the air to circulate.

**The Battlement.** This is made by nailing pieces of board 6 inches square to the walls, above the roof, as shown in Fig. 508. The turret battlements have been described.

The space beneath the floor is plenty large for

**Secret Treasure Vaults**, without which, of course, the castle would not be complete. Boxes fastened between the floor joists, as shown in Fig. 507, will make good vaults in which to store the castle's "gold," and the floor boards over these should be battened together in sections so they may be removed to gain access to the vaults.

**The Drawbridge** should be 1 inch larger all around than the entrance, and its boards should run horizontally and be fastened together with battens (Fig. 511). Cut a piece of broom-handle 8 inches longer than the width of the

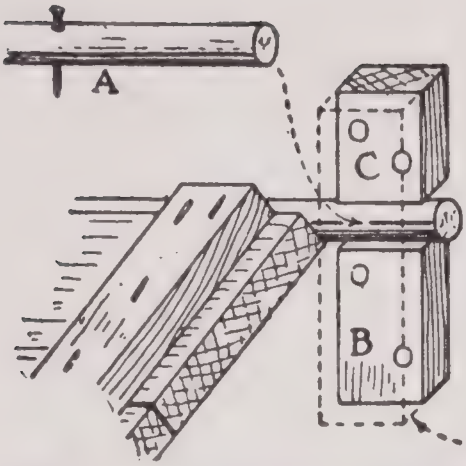



FIG. 510.— Sockets for the Drawbridge.

entrance (*A*, Fig. 510), and nail it to the lower edge of the drawbridge, then make a socket for each end of the broom-handle to set in, by nailing two blocks (*B* and *C*, Fig. 510) to the wall each side of the entrance, and nailing another block (*D*) over these to hold the broom-handle in place.

**To counterbalance the Drawbridge**, get two clothes-line pulleys, four screw-eyes, and about 18 feet of clothes-line. Bore a hole through each batten of thedrawbridge near the end (*A*, Fig. 511), cut two slots in the castle wall above the entrance (*B*, Fig. 511), screw the pulleys into the lower edge

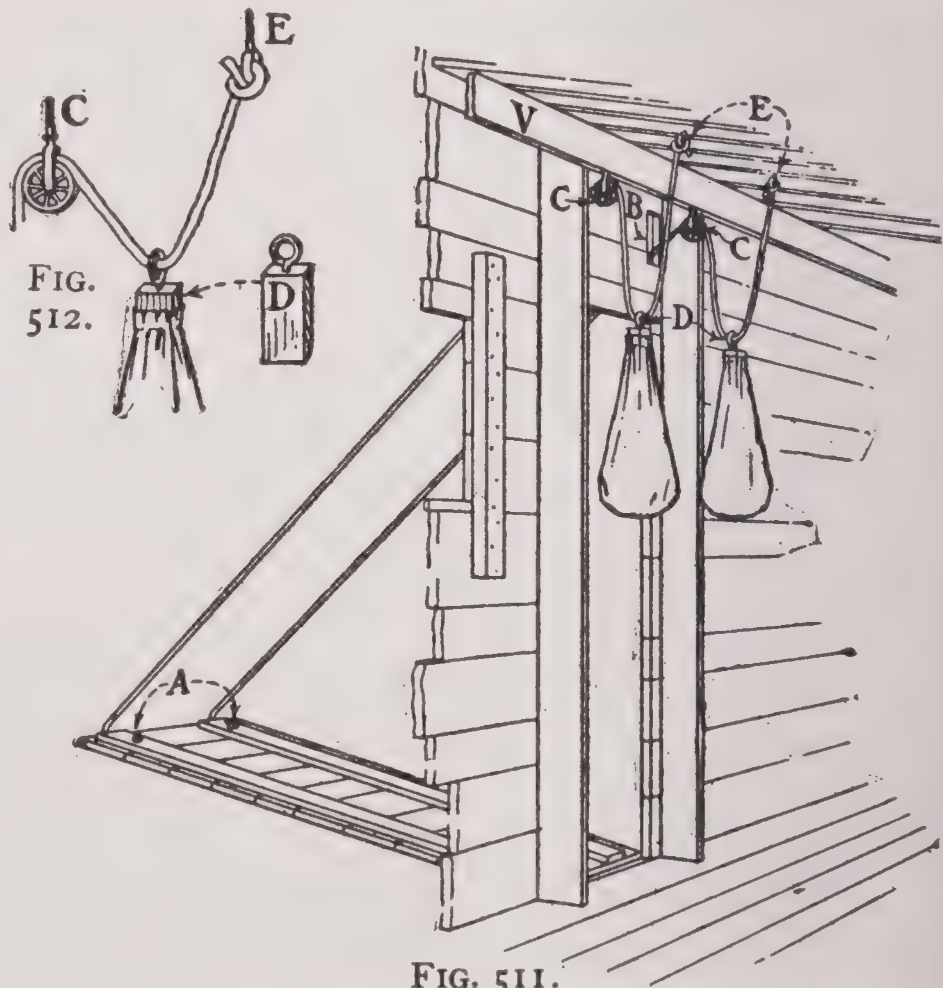



FIG. 511. — How the Drawbridge is Counterbalanced.
FIG. 512. — Details of Counterbalance.

of the horizontal board *V* at *C*, and two screw-eyes into the ceiling at *E*.

For the *counterbalance* take two flour sacks, potato sacks, or two pieces of carpet sewed together in the form of bags; fill them full of sand or gravel, and tack the top of each around a block of wood, in one end of which a screw-eye has been screwed (*D*, Fig. 512). Cut the clothes-line in halves; tie a knot on one end of the pieces; pull them through holes *A* as far as the knotted ends will permit; run them around the ends of the drawbridge, up through slots *B*, over pulleys *C*, through the screw-eyes *D* on the counterbalances, and through screw-eyes *E* (Fig. 511). Then pull up the drawbridge as far as it will go, lower the counterbalances on the ropes until they come within about 6 inches of the floor, and tie the ropes to screw-eyes *E*; cut off the ends of the rope.

**A Windlass** may be substituted for the counter-

FIG. 514.

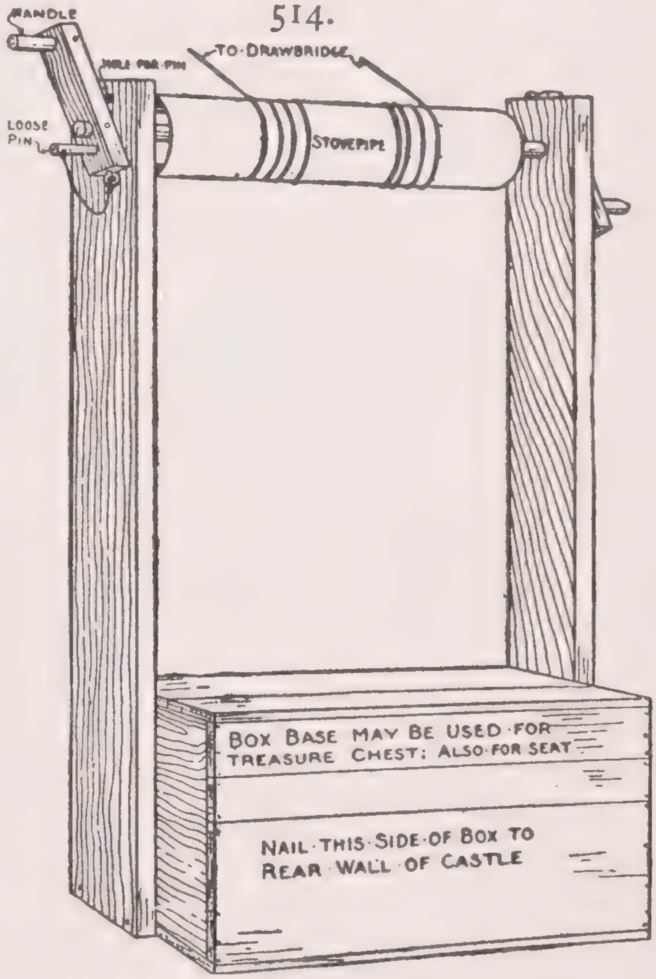



FIG. 513.

FIG. 513. — Windlass for raising the Drawbridge.

(You may make and use one of these instead of the counterbalances shown in Fig. 511.)

FIG. 514. — Shaft for Stovepipe Drum.

balances, if you wish to make one. Figure 513 shows a simple scheme, requiring a section of stovepipe, a broom-handle, a grocery box, and a few boards. Make a shaft for the stovepipe out of the broom-handle; cut two disks equal to the inside diameter of the stovepipe, bore a hole through the center of each large enough for the broom-handle to slip through, and fasten these disks to the shaft (Fig. 514). Slip the shaft through the section of stovepipe, and tack the metal to the wooden disks. Mount the completed drum on two board uprights, and nail the lower ends of the uprights to the ends of the box. Construct a crank for each end of the shaft, fasten them in place as shown, and provide a loose pin to run through a hole bored through each crank and each upright, as a means for locking the windlass; several holes bored through each upright will make it possible to lock the windlass at any point desired. Tie the ends of the ropes leading in from the drawbridge to the drum of the windlass, and fasten them to the metal so they will not slip.

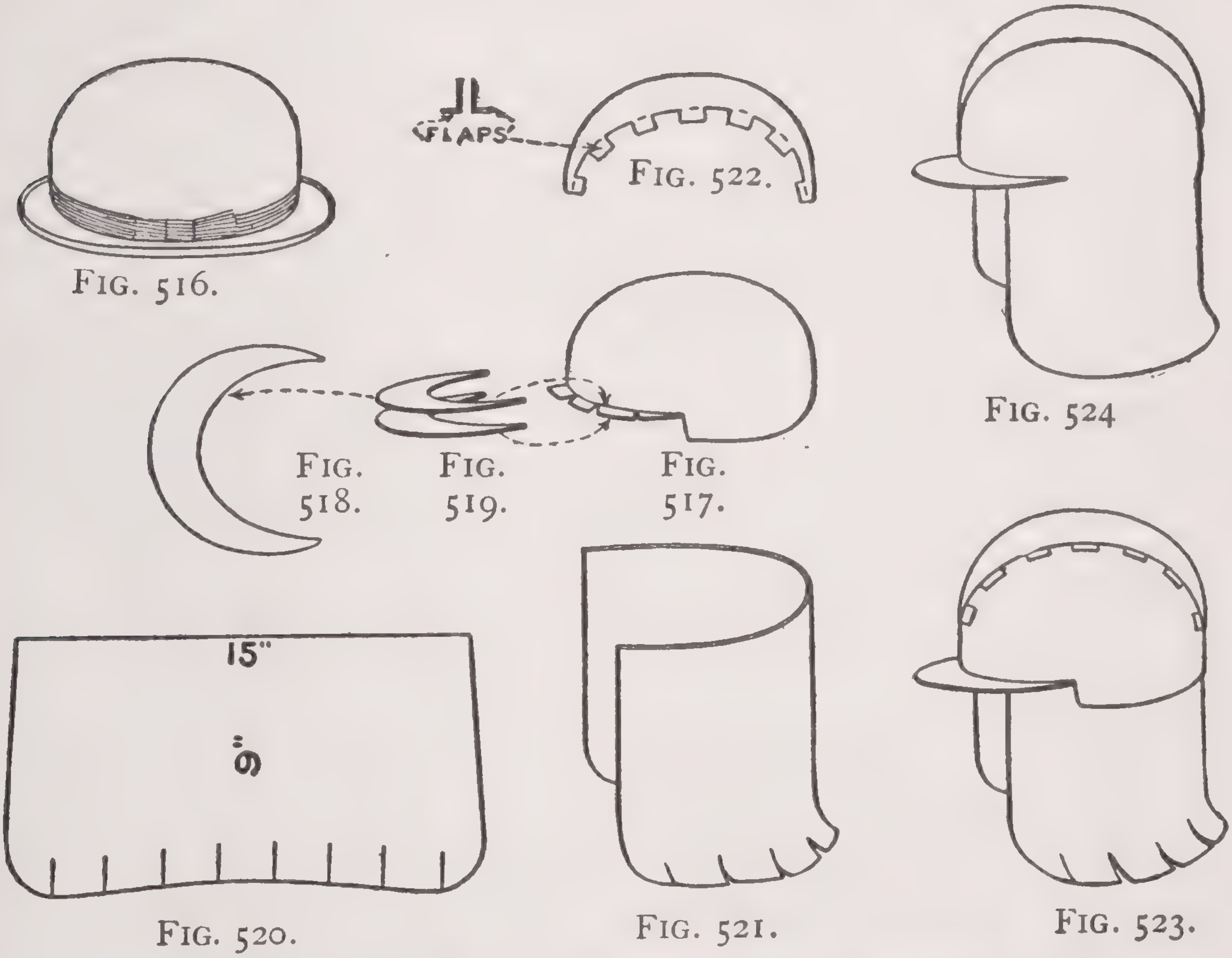
As noted in the illustration, the back of the box base should be nailed to the rear wall of the castle; also connect the upper portions of the uprights to the walls with cross-pieces, to brace them.

**A Moat.** Dig a trench around the outside of the base for a moat, and your castle will be completed.

**Home-made Armor.** Of course you will want some armor with which to dress up like a real knight, so I

have invented for you a home-made helmet, a shield, and a sword, which, with the addition of a pair of gauntlets and a sweater (this resembles, somewhat, the texture of coats of chain mail), will make a fairly complete outfit. Figure 515 shows a boy knight equipped with this home-made armor.

**The Helmet.** Get an old worn-out derby hat (Fig. 516); remove the brim, sweat-band, and ribbon, make slashes 1




FIGS. 516 to 524. — Details for making the Helmet.

inch in length in the edge of the felt from the center of each side around to the front, and bend up the pieces between the slashes (Fig. 517); cut two vizors out of card-

board (Fig. 518), and glue one of these to the tops of the turned-up felt flaps and one to the under sides (Figs. 517 and 519). For the cape or neck portion of the helmet, cut a piece of cardboard to the shape shown in the diagram, and slash the lower edge (Fig. 520); bend this piece of cardboard as in Fig. 521, and bend out the pieces between the slashes, then coat about 2 inches of the top of the cardboard with glue, place it inside of the hat and press it against the felt until the glue has set (Fig. 523). Prepare the two crown ridge-pieces (Fig. 522) out of cardboard, glue the pieces together back to back, and glue the flaps to the crown of the hat (Fig. 523).

Cover the helmet with tin-foil; this can be obtained from a florist, or from the wrappings of chocolate, etc. Glue the tin-foil to the felt and cardboard, and do not try to smooth out the wrinkles too particularly, for these will give the effect of rich carvings such as you will see on ancient helmets. Figure 524 shows our helmet.

**The Shield.** Make a bow out of a narrow stick, bending it so there will be a distance of 2 inches between the center of the stick and the bowstring (Fig. 525), then cut the shield out of a piece of heavy cardboard to the dimensions given in Fig. 526 and tack it to the bow. Cut two blocks of wood 4 inches long, and fasten a piece of twisted wire to the ends of each with screws (Fig. 527) for the arm and hand straps; wrap the wire with cord (Fig. 528), and tack the shield to these blocks. Remove the bowstring and cut off the ends of the bow

FIG. 531. THE TROMBONE.

FIG. 532. THE BASS HORN. FIG. 530. THE CORNET.

FIGS. 530–532. HOME-MADE INSTRUMENTS FOR A BOYS' BAND.

even with the cardboard; then cover the shield with tin-foil or silver paper.

**The Sword.** Cut this about 3 feet long, with a blade $1\frac{1}{2}$ inches wide, as shown in Fig. 529. First bore a $\frac{1}{4}$-inch hole through the stick, 6 inches from one end, then whittle the handle round and bevel off the sides of the blade until the edges are sharp. Drive a piece of iron rod of the size marked through the hole in the handle, for the hilt of the sword; then cover the hilt, handle, and the entire blade with tin-foil or silver paper.

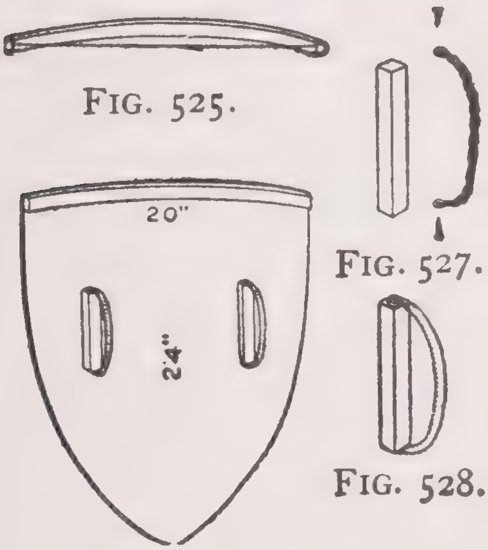



FIG. 525.

FIG. 526.

FIG. 527.

FIG. 528.

FIGS. 525 to 528.—Details of Shield.

FIG. 529.

FIG. 529.—Sword.

# CHAPTER XXVIII

## A BOYS' BAND OF HOME-MADE INSTRUMENTS

The neighborhood parade would be headed by a boys' band, no doubt, were it not for the lack of instruments. This need suggested to the author the idea of devising the home-made cornet, trombone, bass horn, fife, and bass drum shown in the illustrations upon the following pages. They are imitation instruments, to be sure, but they will make plenty of noise, and music, too, if they are properly handled. The notes are produced on the horns by the variation of the voice, and not by the manipulation of keys, so it will be easy for any boy who can carry tunes by ear to play them without having to do very much practicing. If you are not familiar with the tones of the instruments, you can soon become so by listening to the playing of a real band.

The entire band equipment can be completed in a couple of days, if each boy makes his own instrument, and the material should cost but very little, as much of it can be found about the house; most likely something that you will need can be supplied by one of the other boys, in exchange for which you can give him something that he wants.

**The Cornet** (Fig. 530). Procure a quart-size tin funnel for the bell of the cornet and several feet of round stick ½ inch in diameter for tubing; for this some old flagstaffs can be used, or cabinet-maker's ½-inch dowel sticks can be purchased for a few cents a stick. The curved tubing can be formed of rubber tubing as is shown in the illustration (Fig. 533), or by bending a piece of tree branch

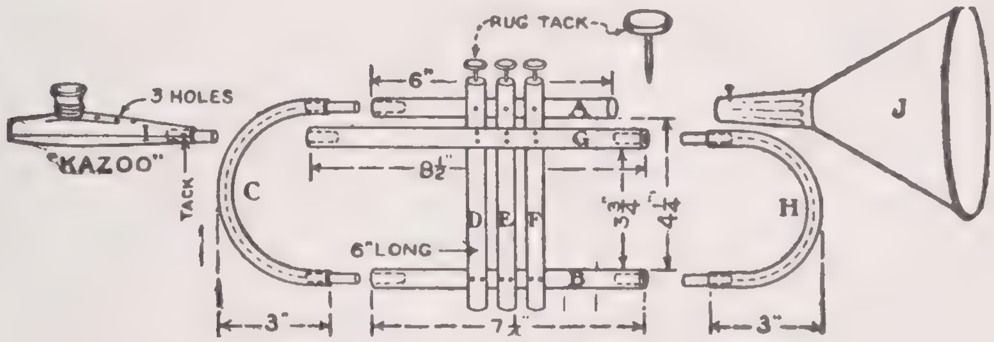



FIG. 533. — Details of Cornet.

to the proper shape (Fig. 538). The lengths of the straight tubing are marked on the diagram, and the pieces are lettered in the order in which they should be assembled. If rubber tubing is used for the ends, run several pieces of heavy wire through it to give it proper stiffness (see dotted lines *C* and *H*, Fig. 533). Bore holes in the ends of the wooden tubing where indicated, and whittle pegs to fit them and the rubber tubing. Fasten the pegs in place with glue, and fasten the other pieces with brads. Drive rug tacks (Fig. 533) into the ends of the key tubes for keys. A "kazoo" is necessary for a mouthpiece. This little instrument, shown in the illustration, will cost a dime, and can be purchased from any music dealer; if he does not carry it in stock, he can procure it for you in

a few days' time. Fasten the kazoo in place by means of a wooden peg; then — as you have stopped up its end — it will be necessary to puncture three holes in the top as shown.

When the tubing, keys, bell, and mouthpiece have been put together, procure some tin-foil from empty cigar boxes, buy some from a florist, or get several 5-cent sheets of silver paper at a stationery store. Cut the tin-foil or silver paper into short pieces, and paste these around the tubing; after sticking it in place, rub each piece with a clean rag to remove all wrinkles. Do the work carefully, as the appearance of the cornet will depend largely upon the neatness with which you cover it.

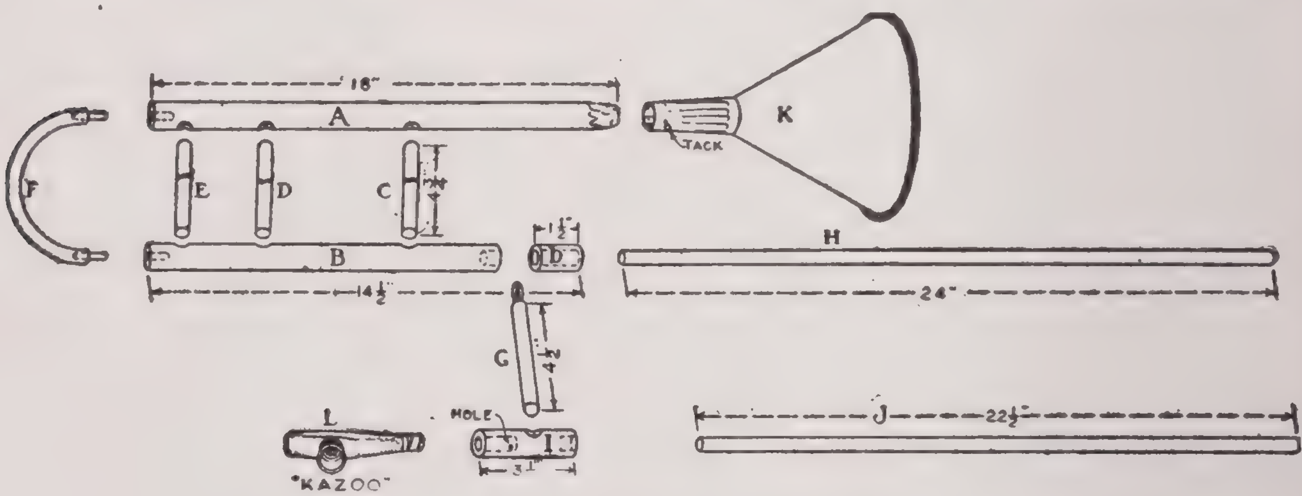



FIG. 534. — Details of the Trombone.

**The Trombone** (Fig. 531) requires a two-quart tin funnel for its bell and a kazoo for a mouthpiece. Figure 534 shows the details for the main portion of the trombone. The large tubing is made of a broom-handle, the smaller tubing of $\frac{1}{2}$-inch sticks, and the curved ends as described for the *Cornet*.

The pieces are lettered in the order in which they should be put together, and their lengths are marked. Bore all the holes shown or indicated by dotted lines, of the proper size for the smaller tubing to fit into. Cut *B* and *b* in one piece, and do not separate them until after you have bored a hole in the end 2 inches deep, which will run entirely through *b* and $\frac{1}{2}$ inch into the end of *B*. The idea is to hinge *G* between *b* and *B*. The screw-eye in the end of *G* should be $\frac{1}{2}$ inch in diameter, inside. Cover the end of tube *H* with glue, run it through *b*, through the screw-eye in *G*, and into the hole in *B*. Wrap the end of the kazoo with paper, and glue it in the hole bored in the end of *I*. Make a gimlet hole in *I* as shown, to let out the tone from the kazoo.

Figure 535 shows the completed *trombone slide*, and Fig. 536 the first step in making it. Cut a number

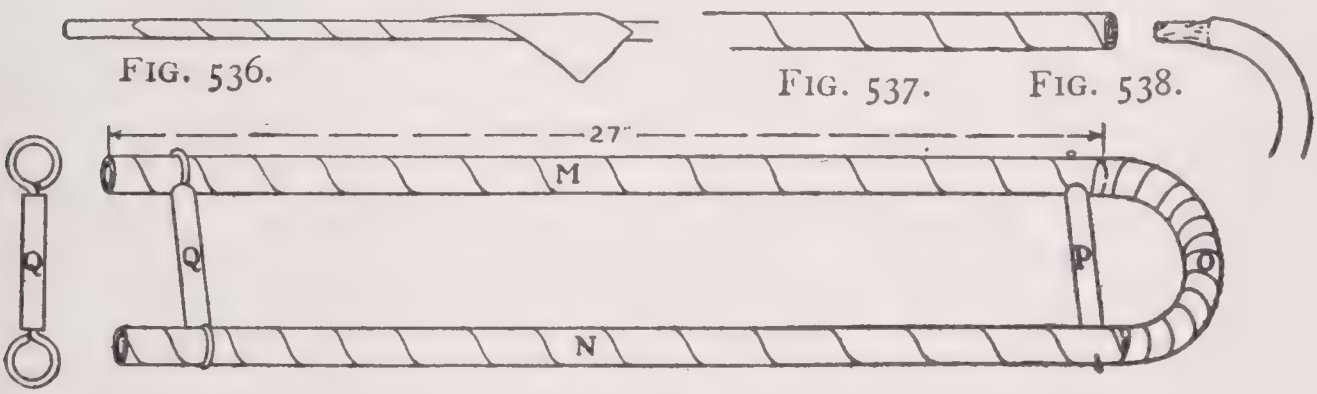



FIG. 536. FIG. 537. FIG. 538. FIG. 539. FIG. 535.

FIGS. 535 to 539. — Details of Trombone Slide.

of strips of newspaper about 3 inches wide and a $\frac{1}{2}$ inch stick about 30 inches long; wrap the stick with a dry strip of paper, then on top of this wrap strips soaked in paste, and gradually build up the tubing until it is as

thick as the broom-handle tubing (Fig. 537). Let the tubing dry thoroughly, then pull out the stick and prepare another tube similarly. The curved end *O* (Fig. 535) may be made out of a tree branch (Fig. 538) or out of rubber tubing (Fig. 533). Fasten *P* between *M* and *N* with brads (Fig. 535). Screw a screw-eye 1 inch in diameter (inside) into each end of *Q* (Fig. 539), and slip them over the paper tubing (Fig. 535). When all the pieces have been put together properly, cover the tubing with silver paper.

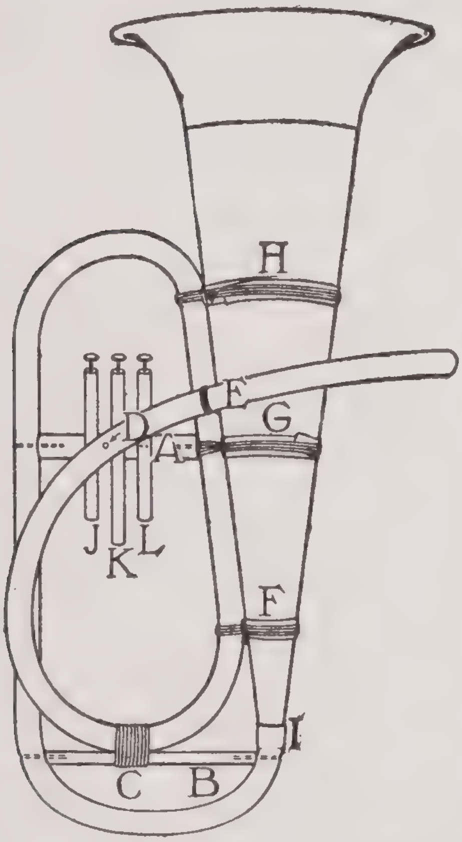


FIG. 540. — Detail of Bass Horn.

**The Bass Horn** (Fig. 532) is made out of a brass phonograph horn and a piece of an old garden-hose. If you haven't an old phonograph from which you can take the horn, you can probably pick up a horn at a second-hand store for half a dollar. The length of this horn will determine the length of the hose tubing, also that of *A* and *B*, but you can follow Fig. 540 in working out the proportions of the instrument. The horn shown in the illustration is 28 inches long, and the garden-hose is 7 feet 6 inches long. The detail shows how the hose should be fastened at *C*, *D*, *E*, *F*, *G*, *H*, and *I*, and that rug tacks are driven into the ends of tubes *J*, *K*, and *L*. The full tone of the horn can be produced by the voice, as the hose tubing is unobstructed.

As you probably know, whistling upon the edge of a card makes a pretty fair imitation of

**A Fife**; we will use this same principle in making our fife shown in Fig. 541. Cut a triangular piece of tin, bend up one corner, and tack it through this corner to a stick 13 inches long, 2 inches from one end. File the edge of the piece of tin blunt and smooth. Bore six "finger holes" in the stick as shown, and cover it with tin-foil or silver paper.

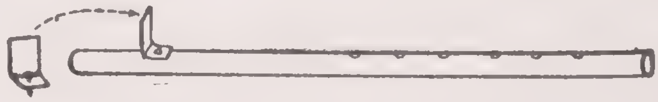


FIG. 541.—The Fife.

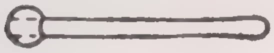


FIG. 543.—The Drum Stick.

Figure 542 shows

**The Bass Drum**, and Fig. 544 the detail of its framework. Procure eight barrel hoops for the framework; also a small drum. Soak four of the hoops in water, then bend them out and fasten them together so as to make two hoops 30 or 34 inches in diameter. Place the drum in the exact center of one hoop, and fasten strips *A*, *B*, *C*, and *D* around it (Fig. 544). Brace the other hoop with strip *E*, then connect the two hoops with 12-inch strips placed horizontally as shown. Fasten the small drum in place with cords (Fig. 544). Cover the entire framework with wrapping-paper, then cut away the portion covering the head of the small drum (Fig. 542). Nail

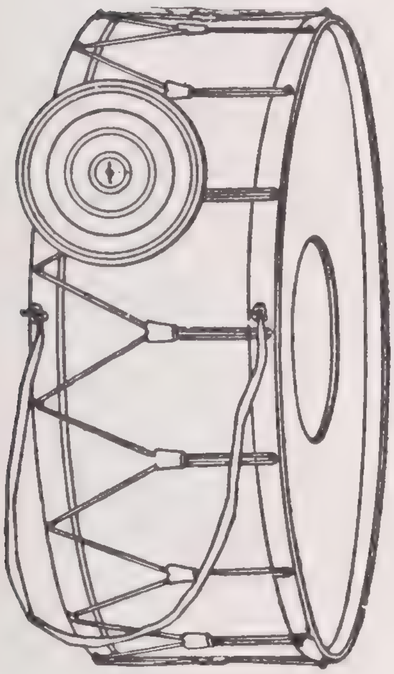


FIG. 542.—The Bass Drum.

the four remaining barrel hoops around the bass drum for rims.

Use small staples for the *brace-cord* hooks (Fig. 545); cut the braces out of canvas by the pattern of Fig. 546,

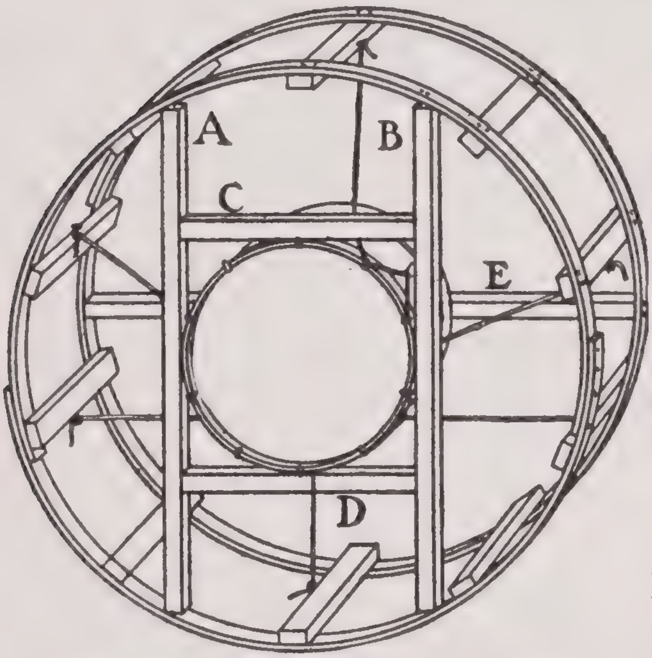




FIG. 546.

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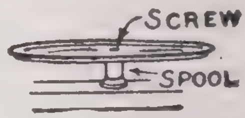



FIG. 547.

FIGS. 545 and 546. — Details of Braces for Bass Drum.

FIG. 544. — Detail of Bass Drum.

FIGS. 547 to 549. — Details of Cymbals.

and sew edge *A* to edge *B*. Get heavy wrapping cord for the brace cord, and lace it back and forth around the drum, as shown in Fig. 542. Screw a screw-eye into each rim from which to attach a rope or tape *sling* (Fig. 542).

**For Cymbals** procure two pot covers; mount one on a spool upon the drum framework (Fig. 547), and fasten a knob (Fig. 548) to the top of the other for a handle (Fig. 549). Pot-cover knobs such as that shown can be bought at any hardware store at 5 cents apiece.

Saw off a 14-inch piece from the end of a broom-handle for

**The Drum-stick**; cut a hole in an old tennis-ball for it to run through, and drive a nail through the ball into the end of the stick (Fig. 543).

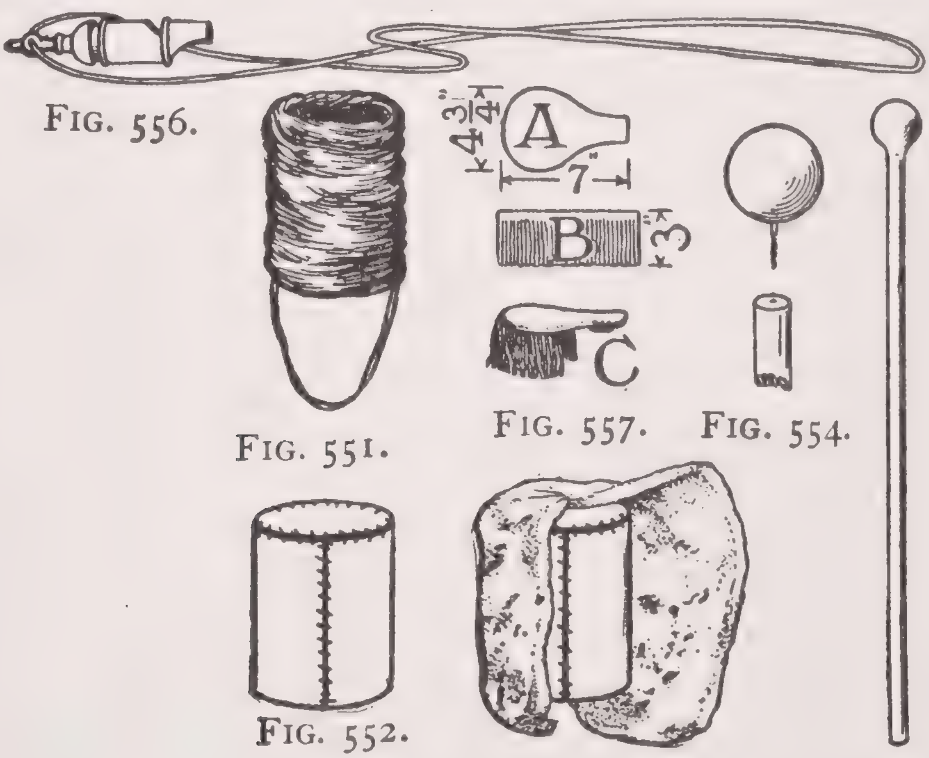
**Snare Drums** can be easily made by stretching canvas or heavy cloth over cheese boxes, but real drums will help to tone up the band and should be used if you can get them.

**The Drum Major** (Fig. 550). Choose for your drum-major the boy who can twirl a stick the best.

If an old fur muff can be had, it will make

**A Splendid "Bearskin" Cap**; sew a piece of elastic to one end of it to go around the chin (Fig. 551). In case

FIG. 550.—The Drum Major.




FIGS. 551 to 557.—Details of Drum Major's Outfit.

you cannot get a muff, make a cardboard cylinder 10 inches in diameter and 12 inches high, and fasten a

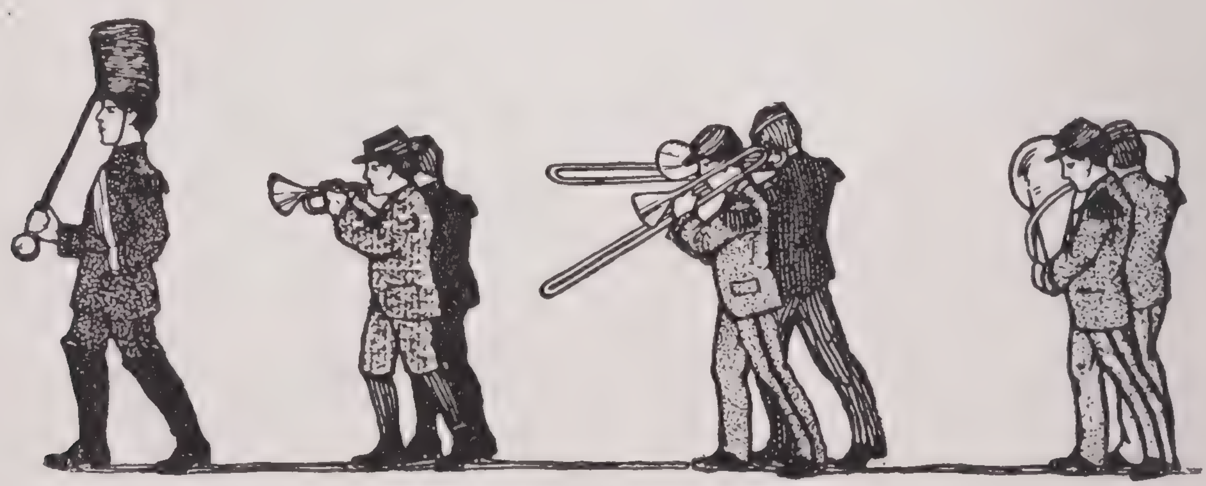
circular piece of cardboard to the top (Fig. 552); then cover it with cotton (Fig. 553).

Cut a piece of broom-handle 3 feet long for

**The Drum Major's Staff**, paint it black, and screw to the head a brass ball from a curtain-pole (Fig. 554); then wrap the joint between the ball and piece of broom-handle with cord until it is filled out, as shown in Fig. 555, and cover the cord with a band of tin-foil. Figure 556 shows

**The Major's Whistle**; with this he signals the band to play. Any toy whistle will do.

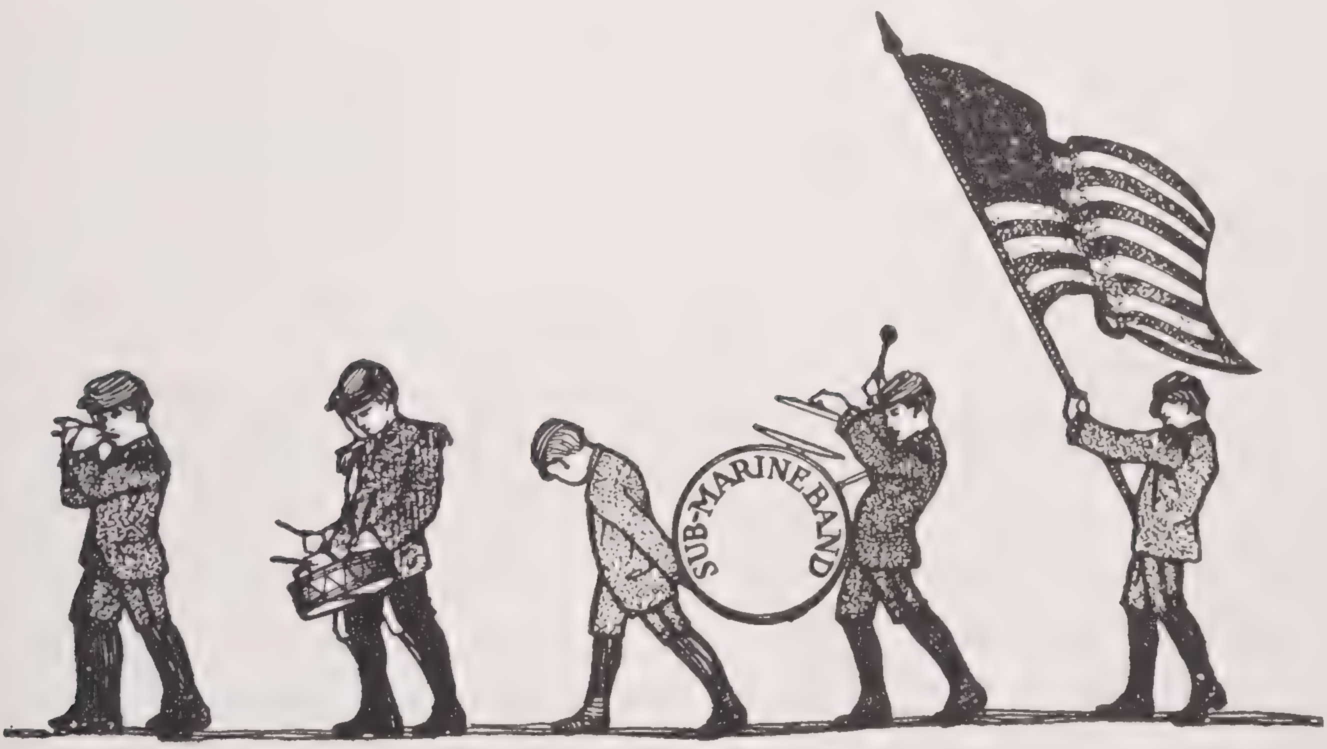
**Uniforms**. The drum major may wear boots if he has a pair, but these are not necessary. He should have a red or blue sash tied across his breast, and red braid stripes pinned down his trousers legs and around his cuffs. Small safety-pins may be sewed to the stripes so they can be attached quickly. Figure 557 shows the way to make the epaulets. Cut a cardboard form similar to *A*, pad it on top with cotton, and cover it with red cloth; then cut fringe out of yellow cloth *B* and sew



it to the edge *C*. Sew a small safety-pin to the under side of *A*.

Figures 530, 531, and 532 will suggest the uniforms for the other band musicians — a soldier cap, a pair of epaulets made similar to the drum major's (see Fig. 557), and red braid stripes for the cuffs and trousers legs.

Now, boys, get to work and organize your band, and after the instruments have been made and you have given a public performance, write and tell me how you succeeded. When your town has a parade on some special occasion, probably you can get permission to head the procession, and when you boys have a vaudeville, a circus, or any kind of a show or entertainment, the band will fill the requirements of an orchestra.



# XXIX
## A PROFILE FUSELAGE GLIDER MODEL

YOU will like this little glider, whether you are a beginner or old-timer in the model game. If you are a beginner, the simplicity of its construction will appeal to you. If you are an old-timer, its neat performance will appeal to you. It is a small, all-balsa job, with a 12-inch wing span, and it weighs only one-sixteenth ounce. A smaller model with a wing span of 10 inches and a larger model with a wing span of 14 inches can also be built.

The PFG-33 profile-fuselage glider is an excellent model for parlor performances. Carry one in your pocket, knocked down, between stiff cardboards. Launch it at a party. Adjust the wing and tail for inside loops, for outside loops, for vertical banks, and other airplane stunts, and watch the fun.

This baby ship, from the model-airplane laboratory of B. C. Friedman, director of handicraft of the South Parks system, Chicago, qualifies for both outdoor and indoor flights.

It may be launched in three ways—hand thrown,

with a tow-line, and by kite release. The photograph of Fig. 558 shows a hand launching.

**The Wing.** Figure 562 of the diagrams shows the PFG-33 with a *flat wing*, and Fig. 563 shows it with a

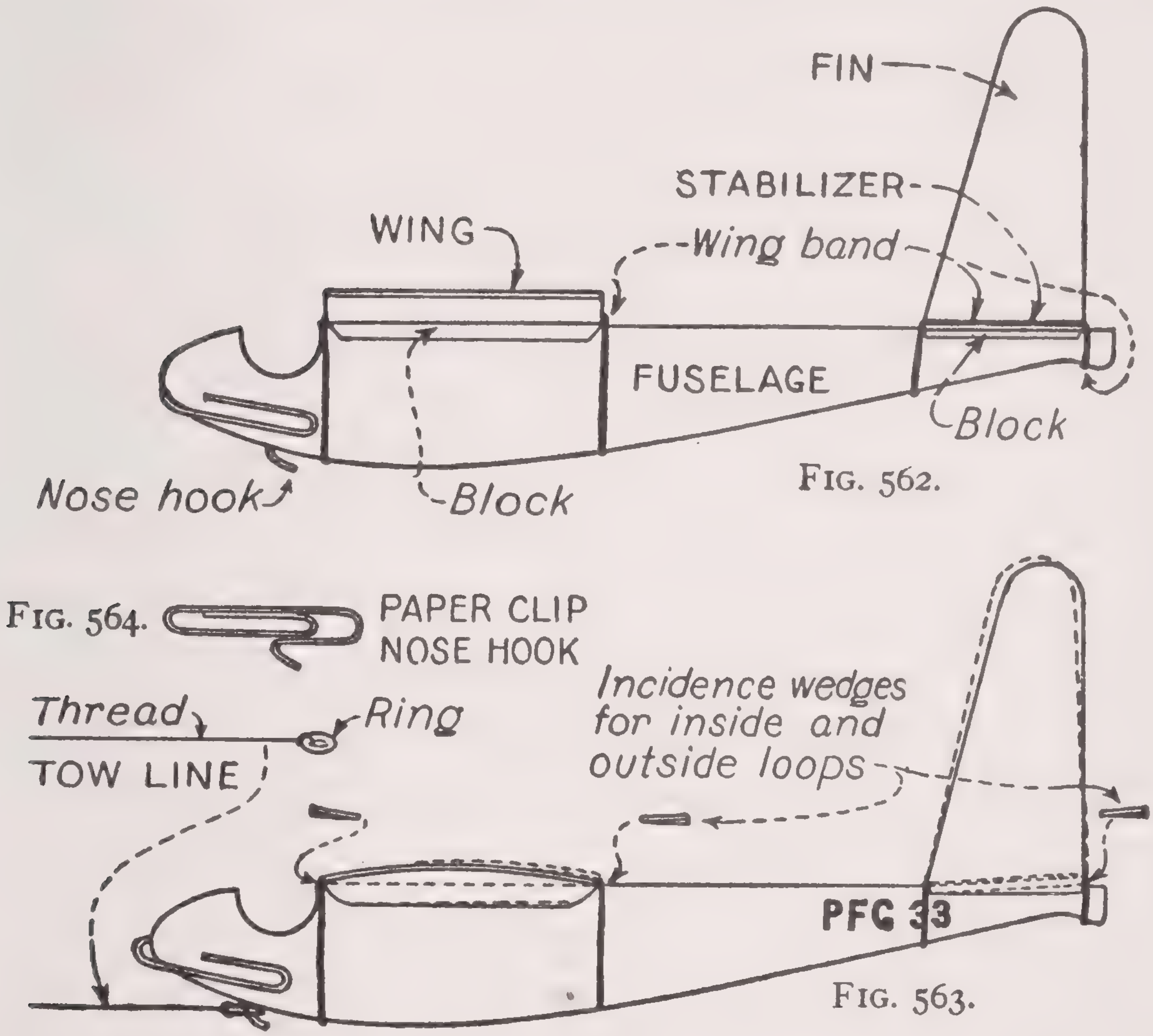



FIG. 562. — Glider with Flat Wing.
FIG. 563. — Glider with Cambered Wing.
FIG. 564. — Paper-Clip Nose-Hook.

*cambered wing.* The latter wing is as easy to build as the former. Wing dimensions are given on the plan (Fig. 565). But to save you the work of laying this out, a full-size pattern of one-half of the wing is given in Fig. 567. Make a tracing of this, and lay it off each

side of a center-line drawn upon a piece of cardboard. Cut out this cardboard templet and mark around it on a piece of balsa $\frac{1}{32}$ inch thick. Sharp scissors will cut thin balsa as easily as paper. But you may prefer to

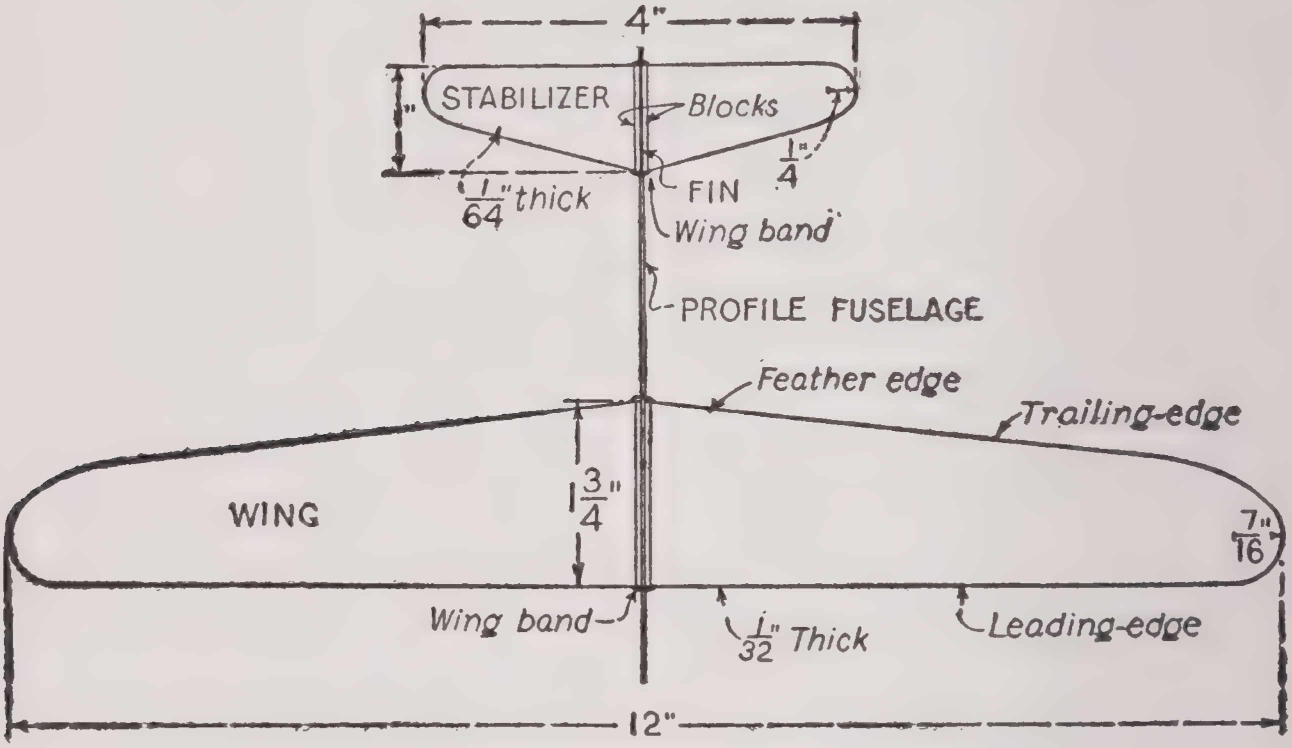



FIG. 565. — Plan of the PFG-33 Glider, from below.

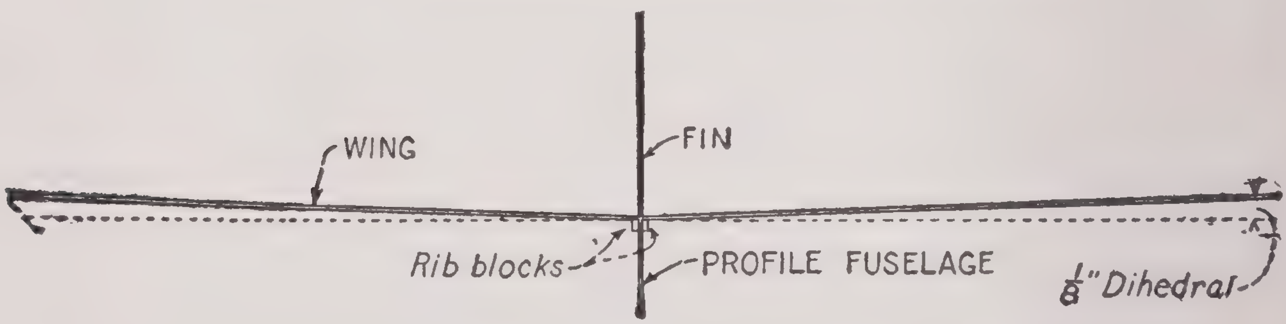



FIG. 566. — Nose View of the PFG-33 Glider.

use a safety-razor blade. When you have cut out the wing, sandpaper its surfaces to taper from a thickness of $\frac{1}{32}$ inch at the leading-edge to a feather edge at the trailing-edge. Use No. 00 sandpaper for the job.

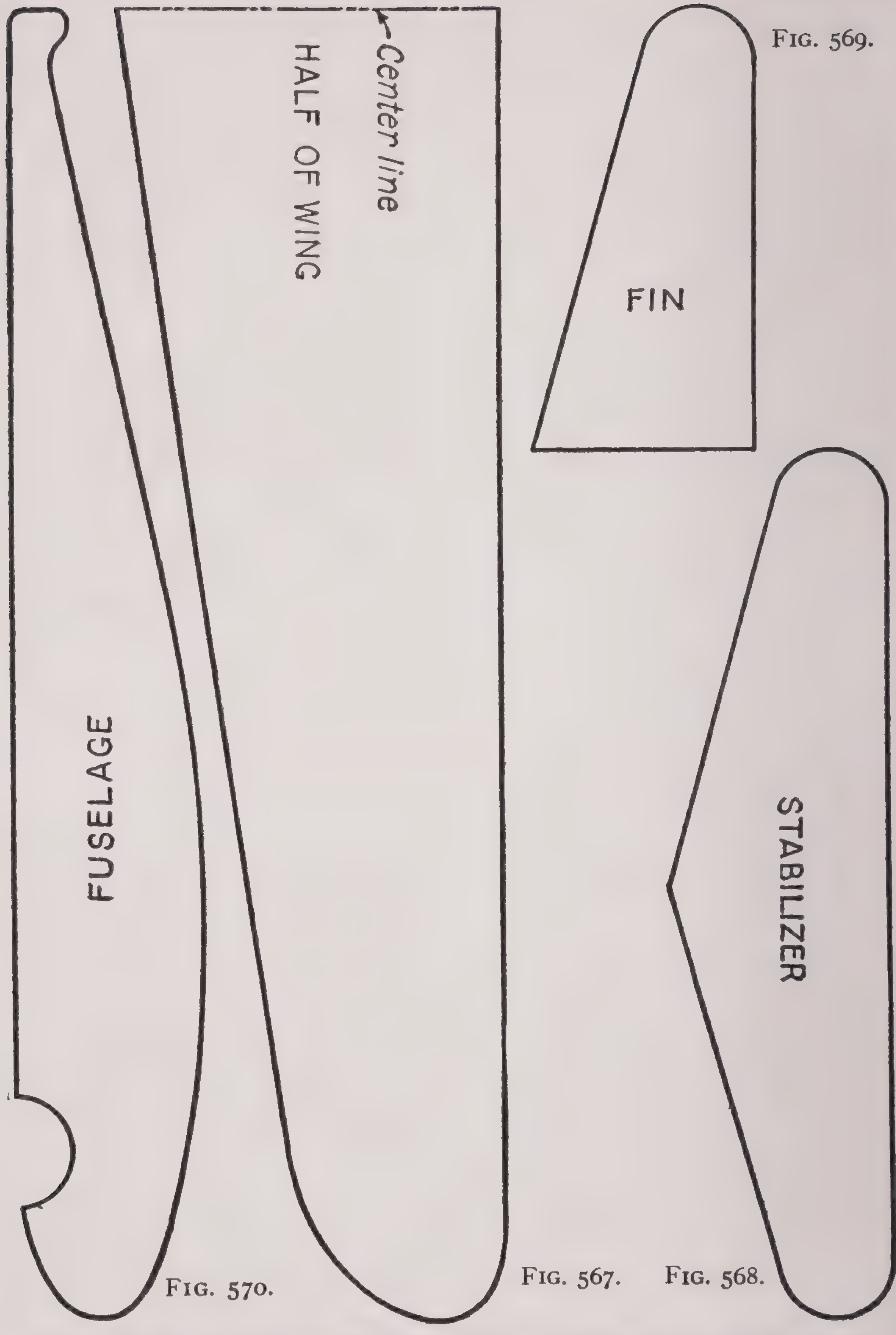
**If You Make a Flat Wing,** give it a dihedral angle (Fig. 566). Place the wing upon a table, press the edge of a ruler across the center to score the wood, and bend up one tip until the dihedral is correct. A thin coat of cement applied to both sides of the wing, at the center, will fix the angle.

**If You Prefer a Cambered Wing,** shape it over a pair of rib-blocks, as shown in Fig. 571. Cut the blocks of the shape and size shown in Fig. 572, and cement them to the under side of the wing a trifle less than $\frac{1}{32}$ inch apart, so that the fuselage will make a slip-fit between them. Mark the positions for the ribs, then cement the ribs one at a time. Coat the edge with cement, bend the wing to the curve and hold until the cement has set.

Figure 573 shows the tail assembly. Make

**The Stabilizer** out of a piece of balsa $\frac{1}{64}$ inch thick. You can cut it out of a thicker piece, then reduce it with sandpaper. A full-size pattern is given in Fig. 568, to simplify laying it out. Make a tracing of the pattern, and prepare a cardboard templet from the tracing. When you have cut out the balsa stabilizer, sandpaper its surfaces from $\frac{1}{64}$ inch at the leading-edge to paper thickness at the trailing-edge.

**The Fin** is of the shape and size of one-half of the stabilizer. Lay it out with the stabilizer cardboard templet, or prepare a separate templet from the pattern in Fig. 569. Cement the fin along the center of the stabilizer.




FIGS. 567–570. — Full-size Patterns of Wing, Stabilizer, Fin, and Fuselage.


FIG. 558.—The PFG-33 Profile-Fuselage Glider.


FIG. 559.—The IT Indoor Tractor Model.


FIG. 560.—Steps in Carving a Propeller.

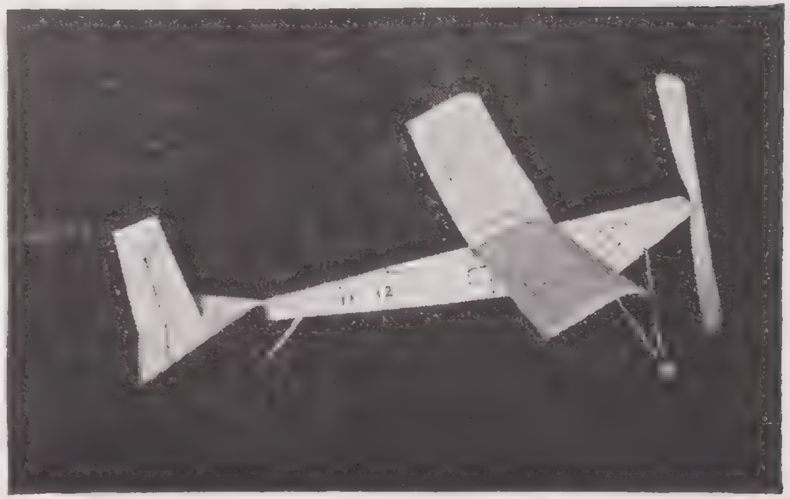


FIG. 561.—The IF-32 Indoor Fuselage Model.

For the tail mounting, cement a pair of small blocks to the under side of the stabilizer, along the center, with just enough space between them for the fuselage to make a slip fit (Fig. 573).

**The Fuselage** is shown full size in the pattern of Fig. 570. Lay it out upon a piece of balsa $\frac{1}{32}$ inch thick. It will make a stronger nose to omit the cockpit opening. You can mark it instead of cutting it.

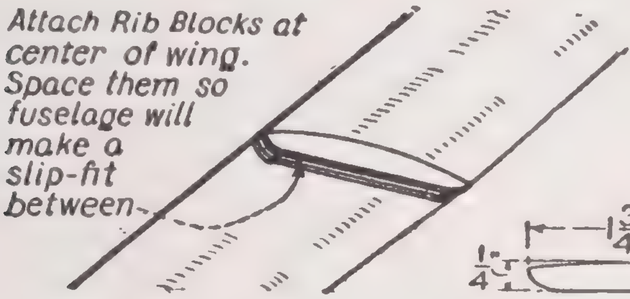



FIG. 571. — Wing Rib Blocks.

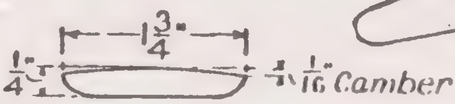



FIG. 572. — Pattern for Blocks.

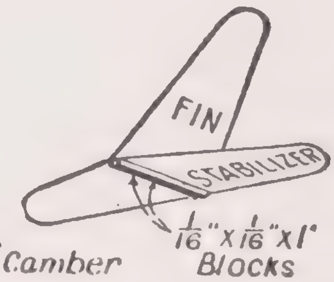



FIG. 573. — Tail Assembly.

**Shape the Nose Hook** out of a wire paper-clip (Fig. 564). This will serve the double purpose of weighting the nose and providing a tow-line hook. Slip the paper-clip over the fuselage, with the hook projecting as shown in Figs. 562 and 563.

**Wing and Tail Bands** will not be necessary for straight gliding, if the fuselage fits snugly between the wing and tail blocks. But they will be needed for adjustments for stunting. The rubber for bands should be very thin. The strands from a golf ball are just right. Form bands of the right size to pass under the fuselage and loop over the wing and the stabilizer, as shown in Figs. 558, 562, and 565.

**For Inside Loops,** the positive *angle of incidence* of the wing and tail surfaces must be increased. To increase it, prepare balsa wedges small enough to slip between the wing rib-blocks and the tail-blocks, at the leading-edge, as indicated in Fig. 563.

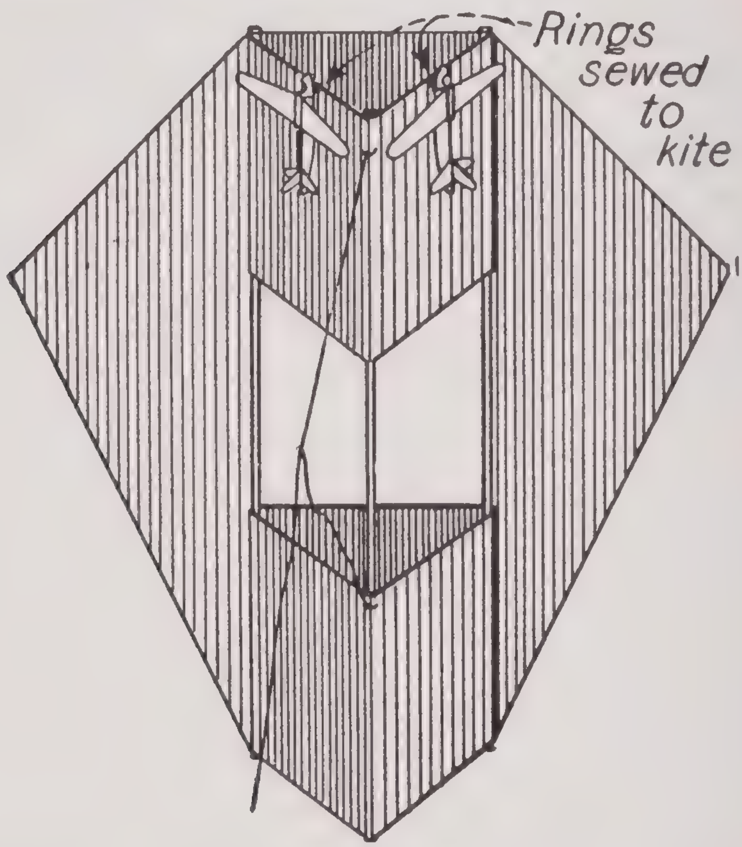



FIG. 574. — Launch a pair of Gliders from a kite. (For Plans for the Conyne Kite shown above, see Chapter XVIII of "Big Book of Boys' Hobbies.")

**For Outside Loops,** a negative angle of incidence is necessary. Produce it by slipping the wedges between the wing rib-blocks and the tail-blocks at the trailing-edge, as indicated in Fig. 563.

**Tuning the Glider.** With the glider assembled, try it out without the incidence wedges, for a level flight. Place the wing and tail in the positions indicated in

Fig. 558. Then, if the model dives at a steep angle, move the wing a trifle forward, or, if it climbs steeply, stalls and slips back, move the wing a trifle back. When you have found the correct adjustment, mark the wing's position upon the fuselage.

**For Launching with a Tow-line,** shape a small ring out of music wire, to slip over the glider nose-hook, and attach a length of cotton thread to the ring (Fig. 563). For indoor launching, make the tow-line 10 or 12 feet long. For outdoor launching, make it as long as you like. To launch, have some one hold the glider until you give the signal to release it. With practice you will acquire the knack of manipulating the tow-line with a quick pull, to start the model in an inside or outside loop.

**For Launching from a Kite,** sew small wire rings to the upper edge of a kite, for the nose-hooks to engage. Figure 574 shows a pair of gliders in contact with a Conyne kite. This is a good model to use. Plans for building it are given in Chapter XVIII of "Big Book of Boys' Hobbies."

With the gliders in position, launch the kite, playing out the line carefully to avoid dives. When an altitude of about 200 feet has been reached, manipulate the line so that the glider or gliders will be shaken free. Then

**An Aerial Circus Performance** will begin, and if you have adjusted one glider for inside loops, the other glider for outside loops, you will enjoy a minute or more of realistic stunting.

# CHAPTER XXX
## AN INDOOR TRACTOR MODEL AIRPLANE

THE IT-31 indoor tractor flying-stick model shown in the photograph of Fig. 559 has been designed with an outrigger tail. This feature has been adopted for

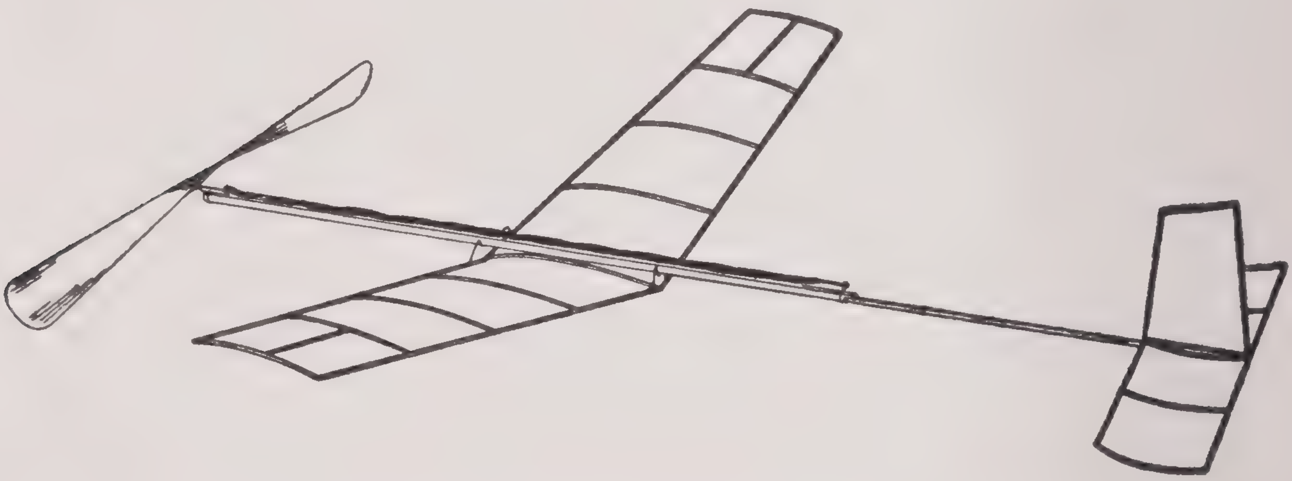


FIG. 575. — The IT–31 Indoor Tractor is a Stick model with Tail Outrigger.

duration-contest models because it makes possible a longer ship without exceeding the 15-inches motor limit, or whatever the contest rules may specify. It throws the center of gravity well forward, makes for greater stability, and produces a smoother, slower flight, most important in a model built for duration. This model also features a stabilizer built with reverse camber on its ribs.

The IT-31 model was designed by B. C. Friedman, director of model aeronautics, of the South Parks System, Chicago. You will find it a simple job, provided that you have learned to work carefully and accurately.

**Material for the Model** includes the following:

1 piece balsa $\frac{1}{8}''$ by $\frac{1}{4}''$ by 16″ for motor base
1 piece balsa $\frac{1}{8}''$ by $\frac{1}{8}''$ by 6″ for outrigger spar
2 pieces balsa $\frac{1}{16}''$ by $\frac{1}{16}''$ by $18\frac{1}{8}''$ for wing spars, or
4 pieces balsa $\frac{1}{16}''$ by $\frac{1}{16}''$ by $9\frac{1}{16}''$ for wing spars
2 pieces balsa $\frac{1}{16}''$ by $\frac{1}{16}''$ by 7″ for stabilizer spars
5 pieces balsa $\frac{1}{32}''$ by $\frac{1}{16}''$ by 12″ for ribs and fin frame
or
1 piece balsa $\frac{1}{16}''$ by 2″ by 12″ from which to cut above strips
1 piece balsa $\frac{5}{8}''$ by 1″ by 11″ for propeller blank
Japanese tissue-paper for papering
No. 10 music wire for metal fittings
Thrust washers
30 inches rubber $\frac{1}{32}''$ by $\frac{1}{8}''$ for motor
Cement and banana oil.

Figure 575 of the diagrams shows the completed model. First, prepare

**The Motor Base.** Cut it of the size shown in Fig. 576, and notch the rear end on the under edge to admit the outrigger spar. Cut the

**Outrigger Spar** of the size shown in Fig. 577, and taper $\frac{3}{8}$ inch of the rear end on which to mount the edge of the stabilizer. Cement the spar in the notch of the motor base, as shown in Fig. 578.

**The Motor Fittings** are shown mounted upon the motor base in Figs. 578 and 579. Dimensions for shaping them are given in Figs. 581 to 587. Make them of

No. 10 music wire, using a pair of round-nosed pliers for cutting and shaping the wire. Make the *propeller bearing* of the shape and size shown in the front and side views of Fig. 581, with the eye round and just large enough for the propeller-shaft to turn in. Make the *rear hook* of the shape and size shown in Fig. 582, with

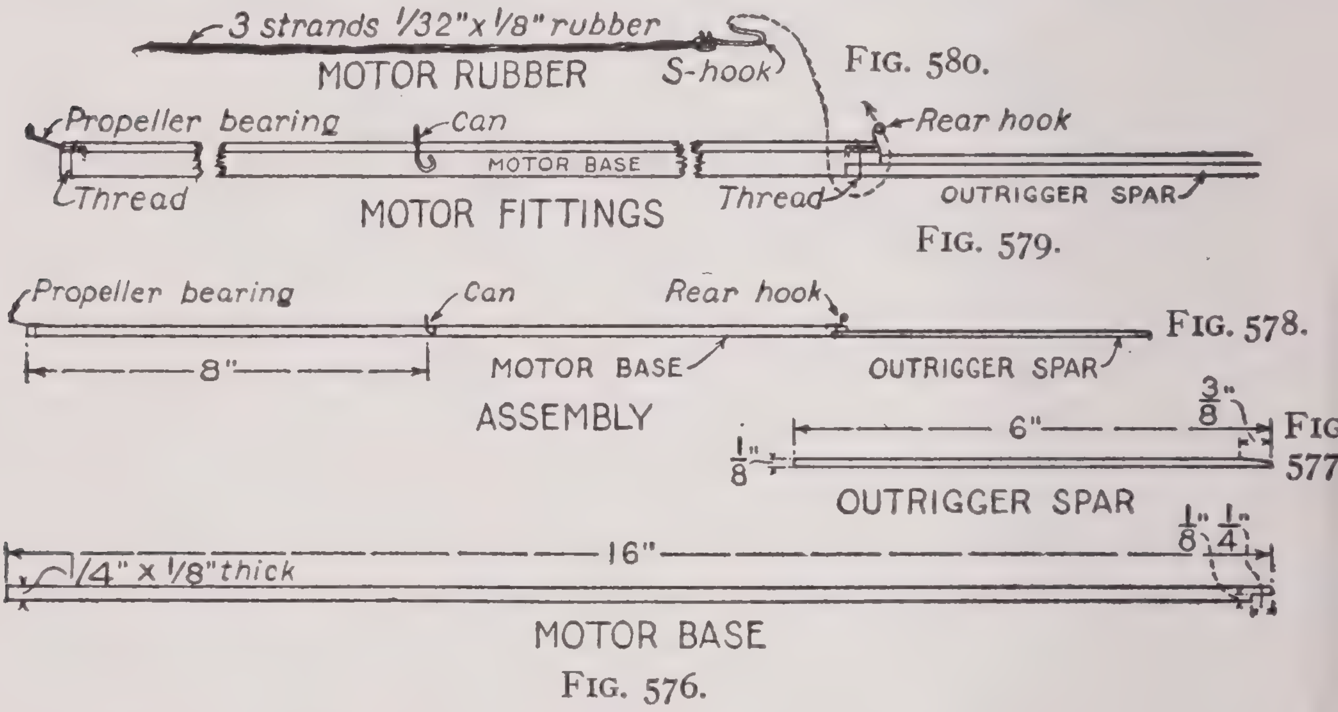



FIG. 576. — Motor Base. FIG. 577. — Outrigger Bar.
FIG. 578. — Motor Base and Outrigger Assembly.
FIG. 579. — Motor Fittings Mounted. FIG. 580. — Motor Rubber.

the eye just large enough for the S-hook to slip into. Two views of the *S-hook* are shown in Fig. 583. Make its eye just large enough to slip the motor rubber loop into. Shape a *can*, or motor-rubber support, of the size shown in the front and side views of Fig. 584.

To mount the propeller bearing and rear motor-hook, coat them with cement, and push the lower tip into the upper edge of the motor base in the positions indicated

in Fig. 579. Tie a loop of No. 50 cotton thread around them and the motor base, as shown, for reënforcement, and coat the loops with cement. Mount the can at the center of the motor base (Fig. 578). Cement the lower loop to the side of the stick.

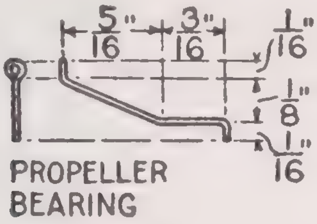



FIG. 581.

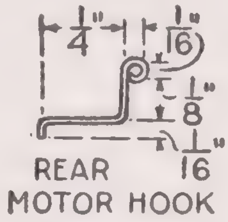



FIG. 582.

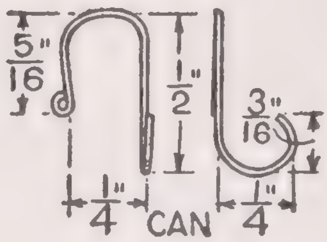



FIG. 584.

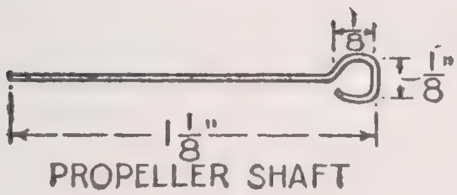



FIG. 585.

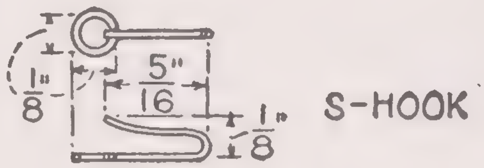



FIG. 583.

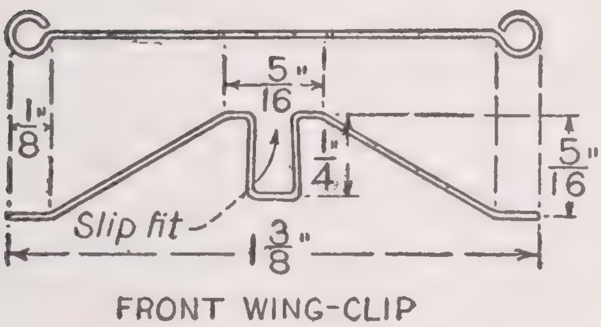



FIG. 586.

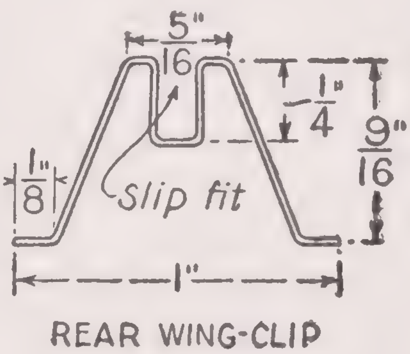



FIG. 587

FIGS. 581–587. —Metal Fittings for the IT-31 Model.

Make the *propeller-shaft* of the length given in Fig. 585, with the end loop shaped as shown. You can make a *thrust washer* by cutting a tiny disk of thin brass, and punching a hole through its center with a phonograph needle. But you will probably prefer to buy half a dozen or so die-cut washers for your models.

The *front wing-clip* is shown in Fig. 586, and the *rear wing-clip* in Fig. 587. You can shape them while making the other metal fittings, or wait until after you have completed the wing. The small loops, or feet, are to be cemented to the wing spars. The center loop must be just right for a slip-fit over the motor-base, and it should knee-in a trifle at the top, as shown.

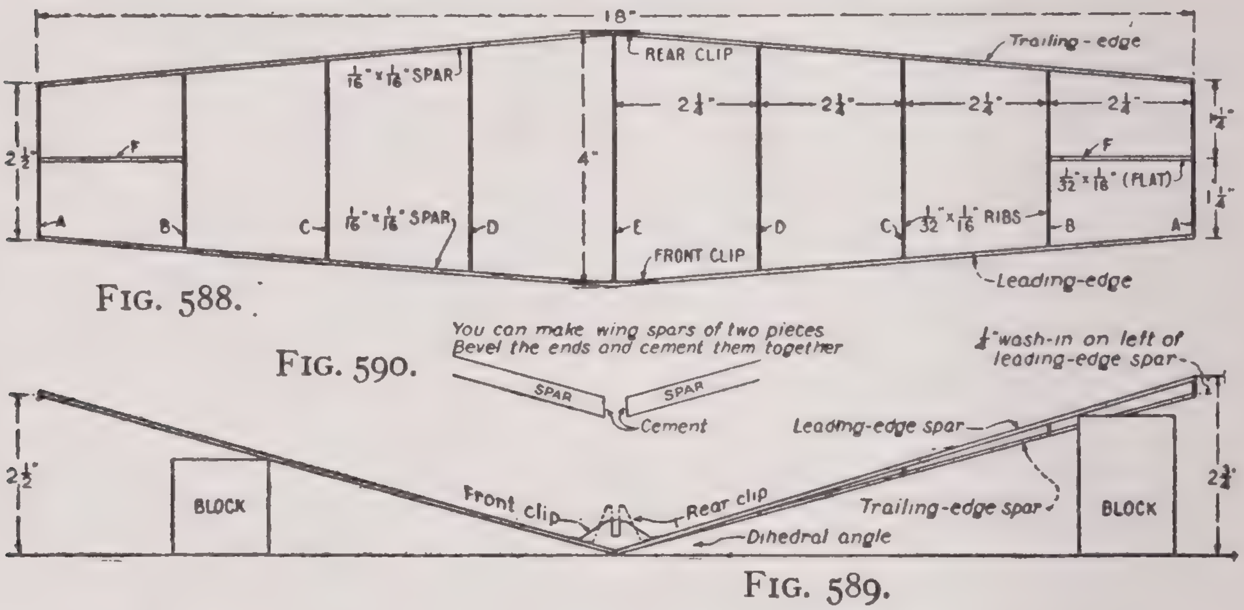



FIG. 588. — Plan of Wing of the IT-31 Indoor Tractor Model.
FIG. 589. — Leading-edge of Wing, showing Dihedral, Wash-in and Clips.
FIG. 590. — You can make Wing Spars of Two Pieces, and join them this way.

**The Wing** of the IT-31 indoor tractor is simpler to frame than the type of wing with bamboo tips and bamboo ribs. The spars and ribs are of balsa. The plan of Fig. 588 gives the dimensions. Unless you buy ready-cut strips, lay them out upon a strip of balsa $\frac{1}{16}$ inch thick, and cut them with a ruler and safety-razor blade.

**The Ribs** are cambered. Full-size patterns are

shown in Fig. 591. Strips of the correct width and thickness can be steamed, then bent over a lighted lamp bulb. But it is easier to cut the ribs with the camber on them, and this type of rib holds its shape. The cutting must be done carefully, because the grain of the balsa will cross the rib ends, and the ends will split off easily. Make cardboard templets for the ribs, following the full-size patterns.

**The Spars** may be of single strips, or two strips joined at the center. One-piece spars must be bent at the center. Hold the strips over the spout of a steaming teakettle, to make the wood pliable. Place them, one at a time, upon your bench, hold the edge of a table knife across the center, raise one end of the spar gently until the distance between the tip and the bench is 2½ inches, and slip a block under the spar to support it (Fig. 589). Then raise the other end of the spar the required distance, and prop it in the same way. Put a drop of cement on the center bend, let it set, then put another drop upon the under side of the bend. The cement will reënforce the bend and fix the angle.

The two-piece spar is as satisfactory as the one-piece spar, and it is preferred by many model makers. To prepare it, trim off the inner end of two spar sticks as shown in Fig. 590, so that when you butt them together they will form the correct dihedral. Give the bevelled ends a thin coating of cement, for a priming coat, and let it set. Then apply a second coat, press the ends

together, check up the measurements between the tips and the workbench, and hold the spars until the cement has set.

**A Wash-in.** The left half of the leading-edge spar must have a $\frac{1}{4}$ inch greater bend than the right half (Fig. 589). This bend, or wash-in, is necessary to offset the twist or torque produced by the right-hand propeller.

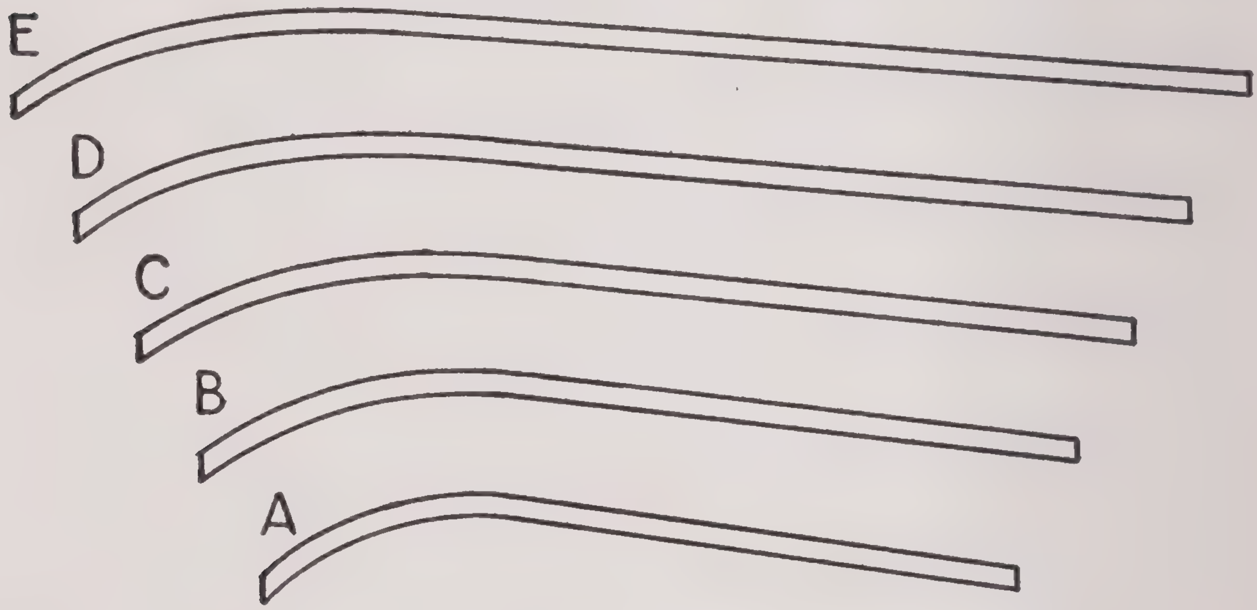



FIG. 591. — Full-Size Patterns of Cambered Wing Ribs.

**The Wing Assembly.** With the spars shaped, cement end ribs *A* between their ends. Then cement center rib *E* between the exact centers, and ribs *B*, *C* and *D* with equal spacing. Cement tip braces *F* between ribs *A* and *B*.

**To Paper the Wing,** cut a piece of Japanese tissue-paper a trifle larger than the wing area, and iron it smooth. Coat the center rib with banana oil, place the center of the tissue-paper over it, and press it down. Then,

working toward one tip, coat the spars and ribs with banana oil, stretch the paper taut, press it down, and

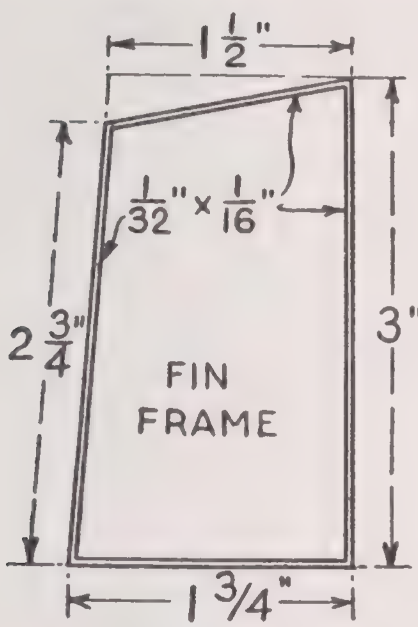



FIG. 594.

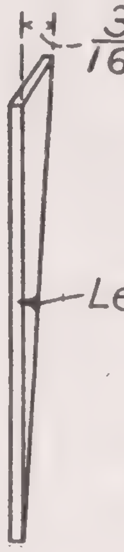
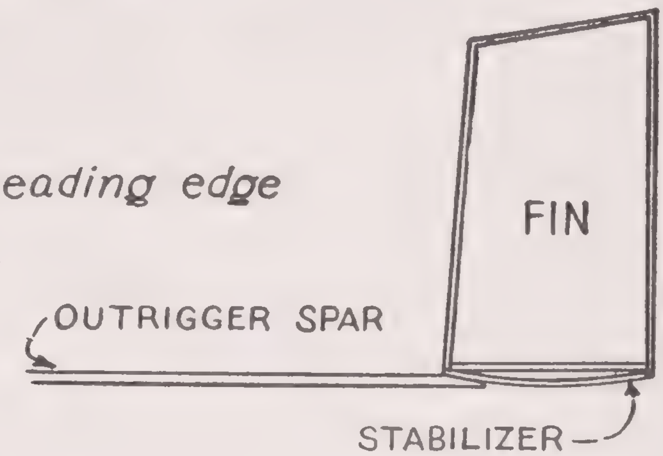



FIG. 596.

FIG. 595.



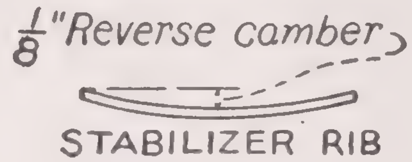




FIG. 593.

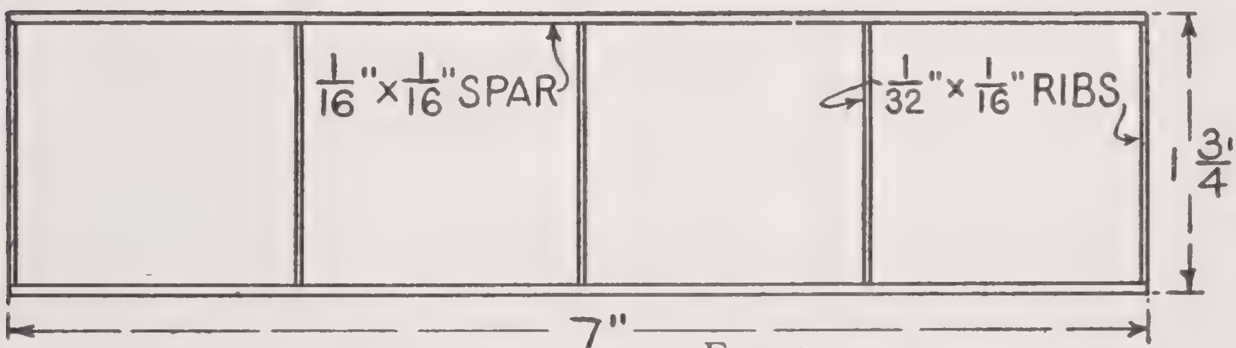



FIG. 592.

FIG. 592. — Plan of Stabilizer Frame.
FIG. 593. — Stabilizer Rib.
FIG. 594. — Fin Frame.
FIG. 595. — Outrigger Assembly.
FIG. 596. — Warp on Tip of Fin.

work out the wrinkles. In the same way, fasten the other half of the paper. When you have papered the wing, trim the edges of the paper close to the spars and

end ribs with a safety-razor blade. Only the upper surface of the frame is to be papered.

Having papered the wing, cement the wing-clips to the spars, as indicated in Figs. 588 and 589.

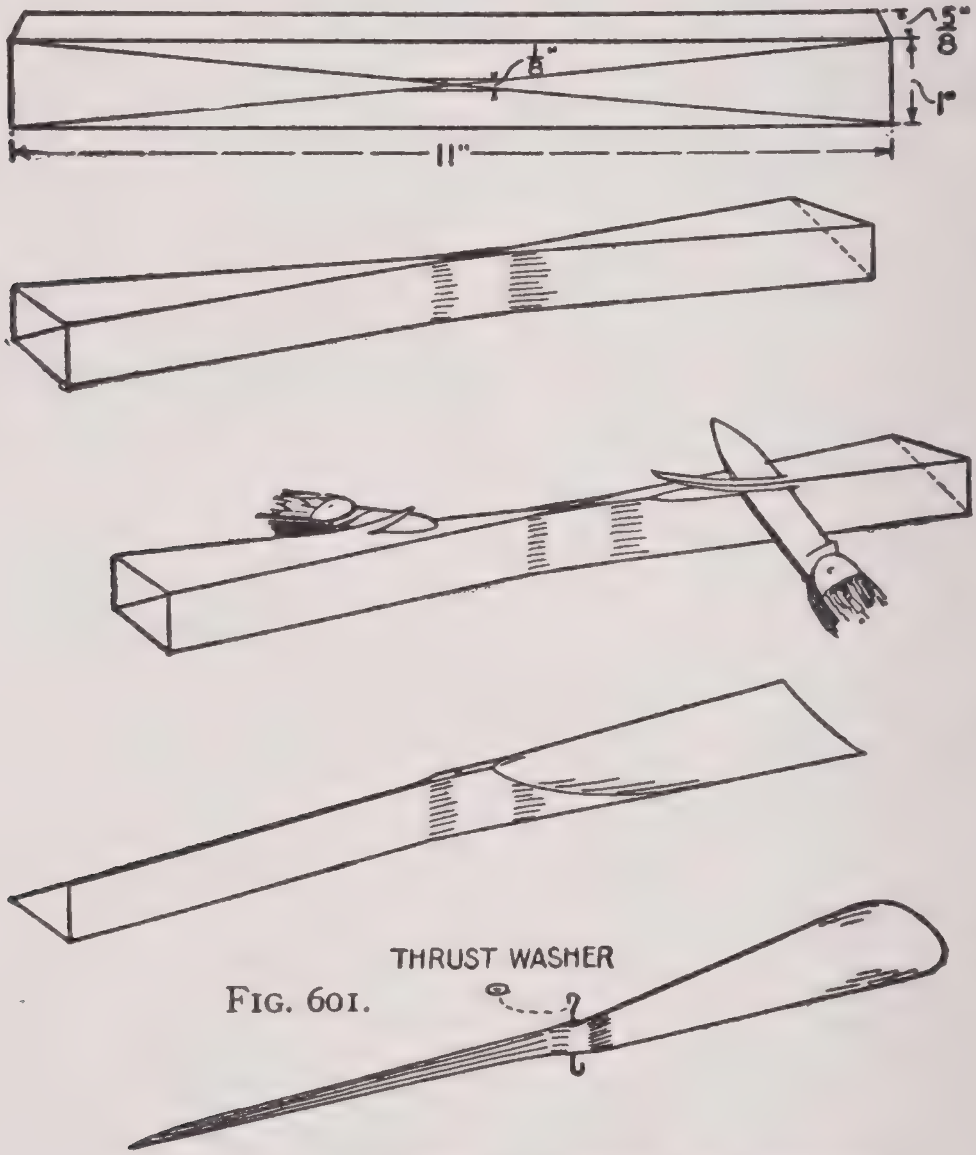



FIG. 597.

FIG. 598.

FIG. 599.

FIG. 600.

FIG. 601.

FIG. 602.

FIGS. 597–602. — Steps in Carving the Propeller.

**Build the Stabilizer and the Fin** in the same way as the wing. Figure 592 shows a plan of the stabilizer frame. Figure 593 shows a rib with its reverse camber. Figure 594 shows the fin frame. Assemble the frames and paper them on one side.

**Mount the Stabilizer** upon the beveled end of the outrigger spar, as shown in Fig. 595, and cement the bottom of the fin across its center. Then breathe upon the top of the fin, and gently warp it to the left, a distance of $\frac{3}{16}$ inch, as indicated in Fig. 596. The warp will help the plane to circle to the left.

**The Propeller** requires an 11-inch block of the width and thickness shown in Fig. 597. After squaring up the block to the given dimensions, draw diagonals through the corners, upon opposite faces, and push a pin through the centers to make a shaft hole. Draw a line one-sixteenth inch each side of the center, parallel to the side edges, to mark off a hub $\frac{1}{8}$ inch across (Fig. 597). Then with a coping-saw or sharp knife cut the edges of the block along the diagonal lines. This will give the block the shape shown in Fig. 598. Next, draw a diagonal line across the block ends, from corner to corner, in the directions indicated in Fig. 598, and you will be ready to start the carving.

**Carving.** First, cut away the wood on opposite edges, as indicated in Fig. 599, a little at a time, until you have reached a point about $\frac{1}{16}$ inch above the end diagonal lines. Even off the surfaces, then smooth them with fine sandpaper, and make them slightly spoon-shaped, or cambered (Fig. 600).

Invert the block, and carve the edges as you did the opposite face edges, to within $\frac{1}{16}$ inch of the end diagonals. Even off the surfaces, and sandpaper them

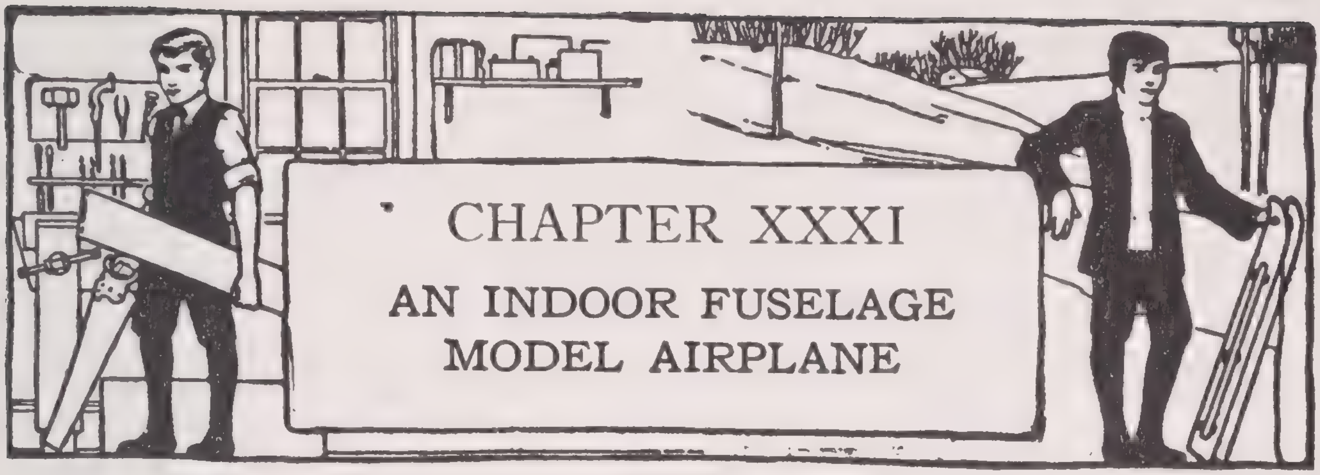
slightly convex. Then reduce the thickness of the blades to about $\frac{1}{32}$ inch, by rubbing down the surfaces with fine sandpaper. Also reduce the width of the hub to $\frac{1}{16}$ inch, and its thickness to $\frac{3}{8}$ inch. Cut away the hub upon the trailing-edge.

The photograph of Fig. 560 shows more clearly the shape of the block after the completion of each step of the carving process.

**To Mount the Propeller,** slip the shaft through the hub, bend over the end, cement it, and draw it back into the wood. One thrust washer is sufficient, but two or three are often used, in which case one of them is cemented to the hub.

**The Motor** for the IT-31 model requires 30 inches of $\frac{1}{32}$ inch by $\frac{1}{8}$ inch flat rubber (Fig. 580). This will make three continuous strands. Make a firm knot in the ends of the rubber, place the knot at the S-hook, and slip the loop over the propeller shaft. Slip the S-hook through the eye of the rear motor-hook.

**Tuning the Model.** To tune the model for a flight, place the wing in about the position shown in Fig. 575, and test out as a glider. If it dives at a steep angle, move the wing a trifle forward, because it is under-elevated. But if it climbs steeply, then stalls and slips back, move the wing back, because it is over-elevated. You will soon find the point at which the model glides on an even keel. By raising and lowering the rear wing clip, you can obtain a fine variation in elevation.



# CHAPTER XXXI

## AN INDOOR FUSELAGE MODEL AIRPLANE

As has been aptly suggested by a builder of the IF-32 model shown in the photograph of Fig. 561 and the diagram of Fig. 603, the IF stands not only for "Indoor Fuselage" but also "I fly." This is to the point. You may undertake this job with the assurance that it will fly and fly well, if you will follow carefully the diagrams and instructions for assembling. This cannot be said of all fuselage models. Many that are trim and fine to look upon are incorrectly proportioned and too heavy for performance.

The IF-32 is another model from the laboratory of B. C. Friedman, director of model aeronautics of the South Parks System, Chicago, and developer of several holders of national championships in model building.

The IF-32 is a balsa and paper model with a wing-span of 24 inches and a fuselage 16 inches long. It tips the scales at slightly less than $\frac{1}{4}$ ounce. You will find it one of the simplest of fuselage models, and if you are skillful, you can complete it in a day's time.

**The Material** includes the following:

6 pieces balsa $\frac{1}{16}''$ by $\frac{1}{16}''$ by $16\frac{1}{2}''$ for fuselage longerons and formers
3 pieces balsa $\frac{1}{16}''$ by $\frac{1}{16}''$ by $12''$ for wing spars and landing-gear struts
5 pieces balsa $\frac{1}{32}''$ by $\frac{1}{16}''$ by $12''$ for wing ribs and stabilizer and fin frames
1 piece balsa $\frac{1}{16}''$ by $\frac{1}{2}''$ by $4''$ for incidence blocks, tail spar and skid,

or

2 pieces balsa $\frac{1}{16}''$ by $2''$ by $16\frac{1}{2}''$, from which to cut above strips
1 piece balsa $\frac{7}{8}''$ by $1\frac{3}{16}''$ by $10''$ for propeller blank
Japanese tissue-paper for papering
No. 8 music wire for metal fittings
Thrust washers
31 inches flat rubber $\frac{1}{32}''$ by $\frac{1}{8}''$ for motor
12 inches rubber $\frac{1}{16}''$ by $\frac{1}{16}''$ (golf ball rubber) for wing-bands
Cement and banana oil

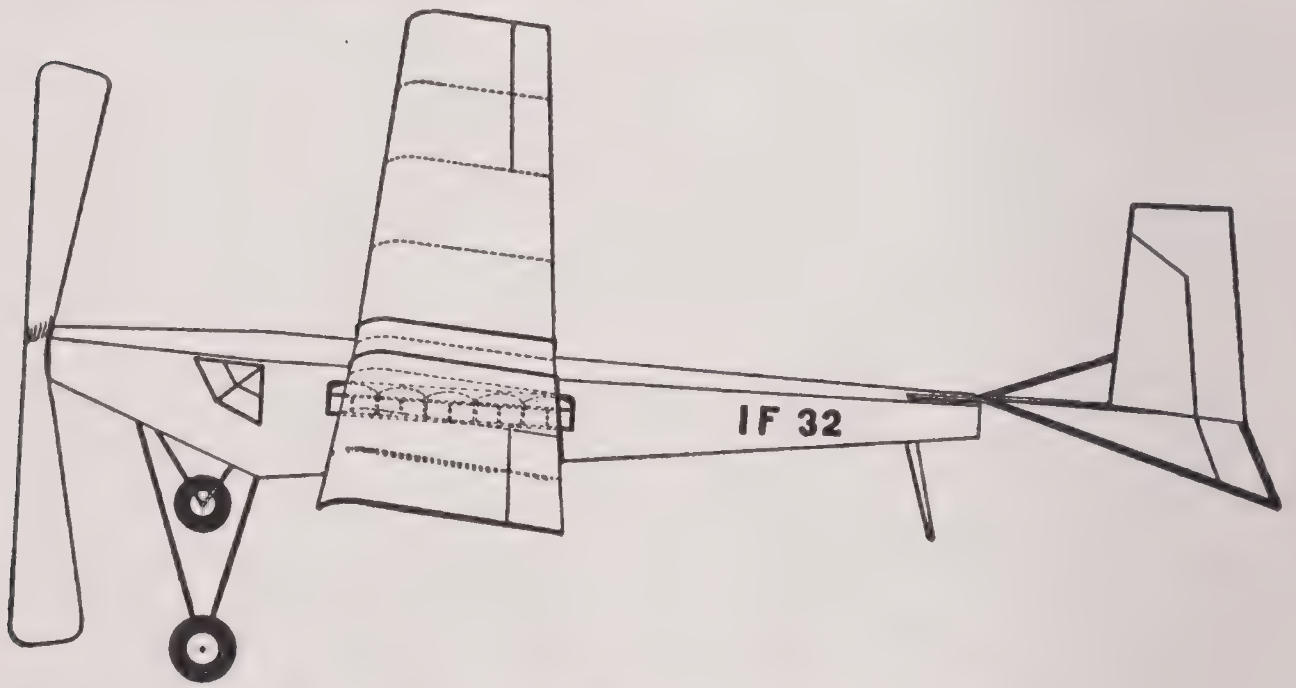



FIG. 603. — The IF–32 Indoor Fuselage Model.

Begin the IF-32 model by building

**The Fuselage Framework.** A detail of the assembly is shown in Fig. 604. It consists of two side frames like

that in Fig. 605, joined with horizontal *formers*. The balsa used for the *longerons* and formers should be of a hard grade of balsa. If the balsa you buy is soft, increase the width and thickness of the strips a trifle. If you purchase the balsa in wide pieces instead of in strips of the specified dimensions, get it in pieces $\frac{1}{16}$ inch thick. Rip it into strips $\frac{1}{16}$ inch wide for the longerons and formers, using a ruler for a straight-edge and a safety-razor blade to cut with.

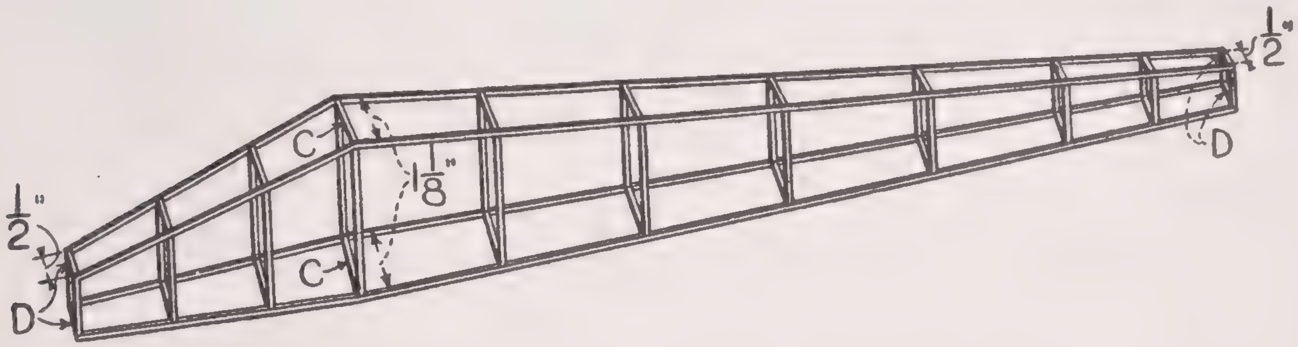



FIG. 604. — Fuselage Framework of the IF-32 Model ready for Papering.

To simplify the assembling of the side frames, a full-size pattern is shown in Fig. 634. This is shown in four pieces. With a piece of transparent paper, make careful tracings with pencil and ruler. Join the longeron ends *A* of the first part to ends *A* of the second part, then join ends *B* of the second part to ends *B* of the third part, and join ends *C* of the third part to ends *C* of the fourth part. Your full-size frame pattern will then be complete. Paste it to a smooth board, and then build a side frame upon it, longeron upon longeron and former upon former. Notch the upper edge of the lower

longeron slightly, at the point where it turns up, and bend it to the angle of the pattern. In assembling a frame, first lay the longerons upon the pattern and hold them with pins or brads driven each side of them. Cut former strips *A* and *B* (Fig. 605) to fit between the longerons, and cement them in place. Then cut the intermediate formers and cement them in their positions.

Use ambroid or similar cement, rather than glue, for

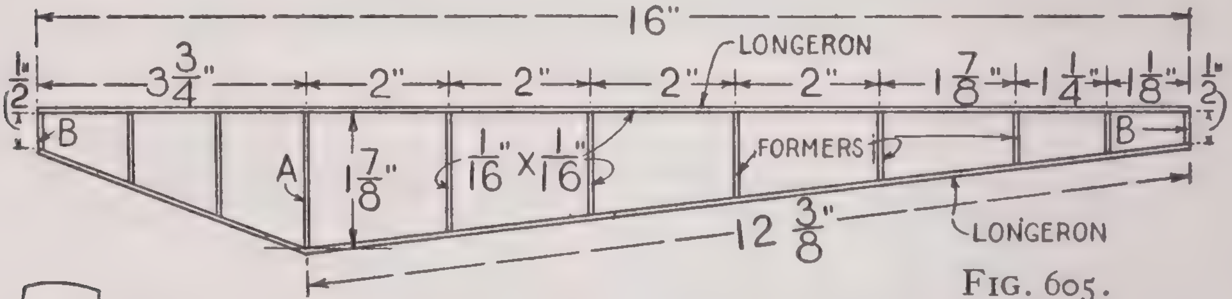



Fig. 605.

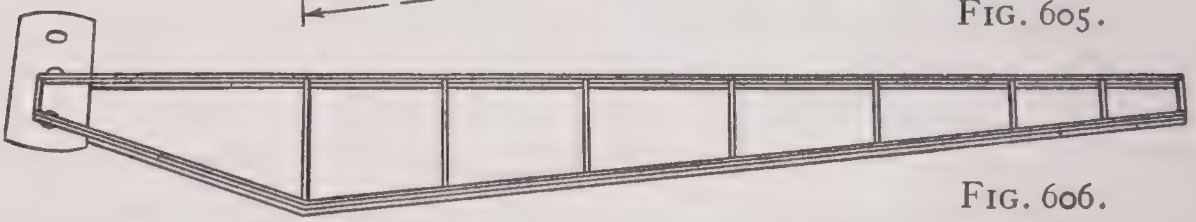


Fig. 606.

Fig. 605. — Plan of Fuselage Side Frames of the IF-32 Model.
Fig. 606. — Build the Frames one upon another, then separate them.

assembling the frames, because it sets more quickly, makes stronger joints, and is lighter in weight.

When you have completed one frame, build the second frame on top of it, as shown in Fig. 606, in order to get the pair identical. Then run a safety-razor blade between the frames, as indicated, to dislodge any cement that may bind the pair together.

As you will see by Fig. 604, there is a side taper to the nose of the fuselage. Steam the longerons at the point where the taper begins, and bend carefully.

To connect the frames, stand them as shown in Fig. 604, and cement the formers *C* and *D* between them. The lengths of these strips are given in Fig. 604. Then cut the intermediate formers and cement them in place.

**Paper the Fuselage** with Japanese tissue-paper, using banana oil for adhesive. Cut strips of the paper a trifle larger than each side, the top and the bottom. Smooth them with a heated iron. Then, beginning at one end of the framework, coat the longerons and formers of one side with banana oil, lay the paper down,

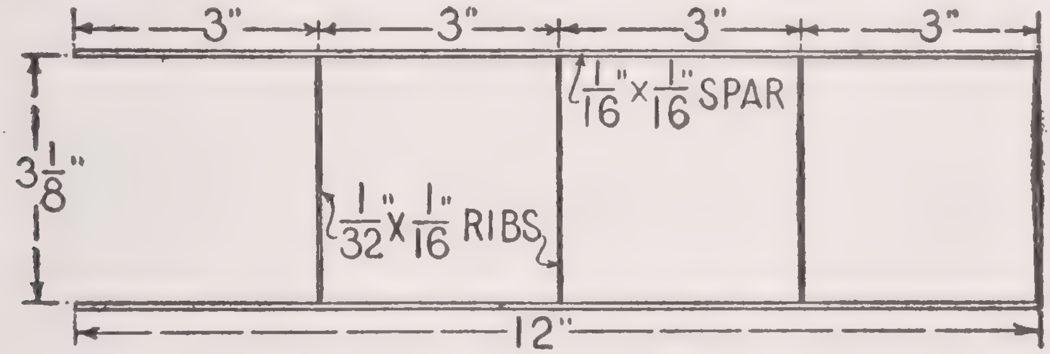



FIG. 607. — Plan of Half of Wing Frame.

stretch it tightly and rub out wrinkles. In this way, coat and cover one section at a time, until the opposite end of the fuselage framework is reached. Then trim off the edges of the paper with a safety-razor blade.

**The Wing.** You will find it easier to construct the wing frame in halves (Fig. 607) and join the halves, than to build it in one piece. Cut the *spars* of the size shown in Fig. 607. Cut the *ribs* out of balsa $\frac{1}{32}$ inch thick, of the dimensions shown in the full-size pattern of Fig. 608. Instead of bending the ribs to give them camber, cut them of the correct shape, with the grain

of the wood running horizontally. Make a cardboard templet of the shape of the pattern, then mark out around it upon a piece of balsa, placing one rib below another, as indicated in Fig. 609, and cut with a razor-blade. Mark the positions for the ribs upon the spars, and cement the ribs in place.

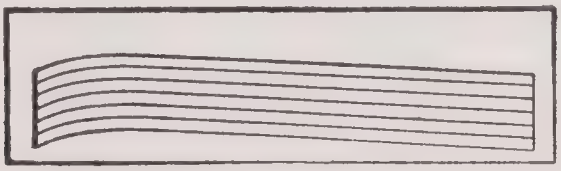


FIG. 609.

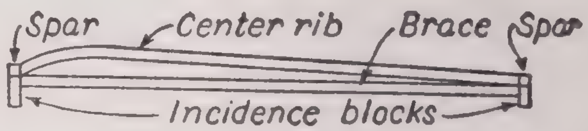



FIG. 610.

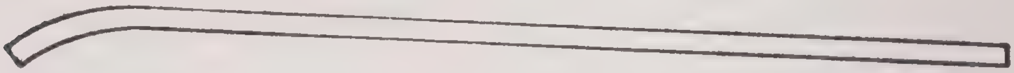


FIG. 608.


FIG. 612.


FIG. 611.

FIG. 608. — Full-size Pattern of Rib.
FIG. 609. — Ribs can be Cut out in this Manner.
FIG. 610. — Sections through Wing at Center.
FIGS. 611 and 612. — Wing-Incidence Blocks.

**To Join the Wing Halves,** block them up as in Fig. 613, so that the trailing-edge and the right leading-edge tips are $1\frac{1}{2}$ inches above your work-bench, and so that the left leading-edge tip is $1\frac{3}{4}$ inches above the bench. This will give the left tip of the wing a $\frac{1}{4}$-inch *wash-in*, to offset the *torque*, or twist, produced by a right-hand propeller. Trim off the inner ends of the wing spars so that they will fit together with close butt joints. Coat the ends with cement, press together and hold until the cement has set.

Complete the wing framework by cementing the center rib between the spars. Then fit a straight strip of balsa between the spars below the center rib, as shown in Fig. 610, for a brace.

**Papering.** Cover the wing with Japanese tissue-paper. Paper one half, then the other. Apply banana oil to the framework, a short distance at a time, lower the paper into place, stretch it, and work out wrinkles by

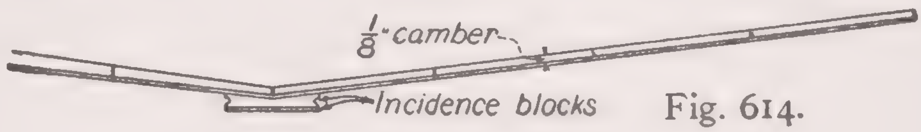



Fig. 614.


Fig. 613.

Fig. 613. — Trailing-edge of Wing, showing Dihedral, and Wash-in on Left Tip.
Fig. 614. — Detail of Wing with Incidence-blocks attached.

rubbing gently. Slight slackness in the tissue-paper may be taken up by shrinking, either by steaming or applying airplane dope. To steam, hold the wing over a jet of steam from a teakettle, then allow the paper to dry, and repeat if necessary. Steam the tissue-paper a little at a time, because there is danger of shrinking it too much and warping the wing.

**A Pair of Incidence Blocks** are necessary to support the wing upon the fuselage. Cut them of balsa wood $\frac{1}{16}$ inch thick, of the shape shown in the full-size patterns (Figs. 611 and 612). The ends are notched

for the loops of the rubber wing-band. Glue the blocks to the wing spars, as shown in Fig. 614.

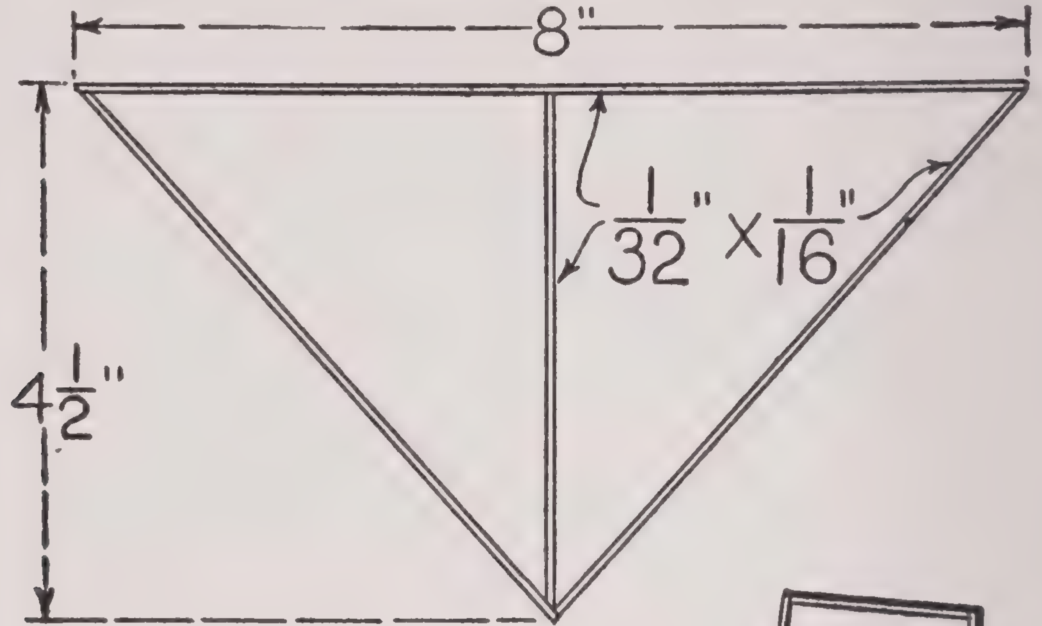



FIG. 616.

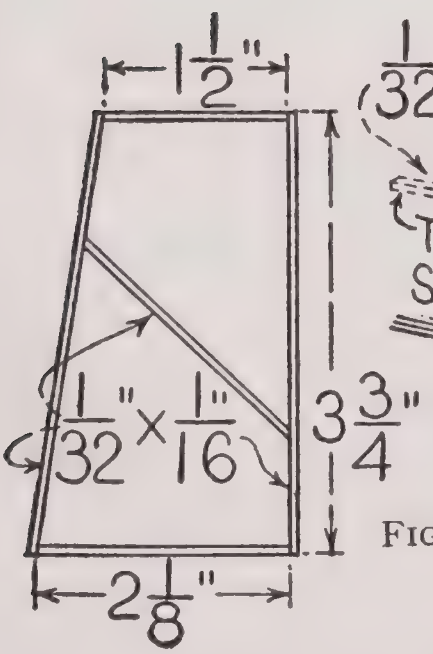



FIG. 617.

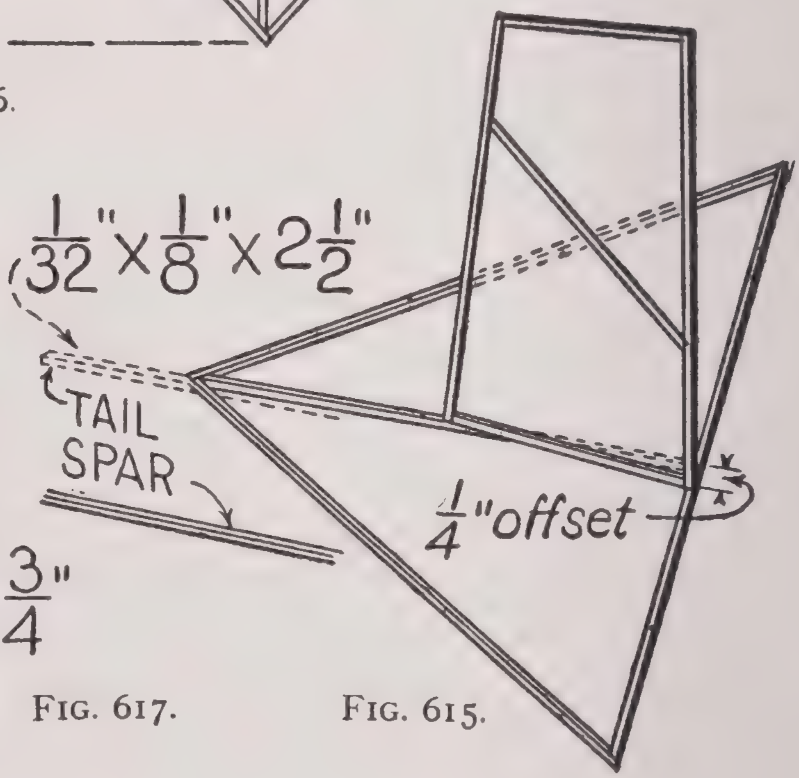



FIG. 615.

FIG. 615. — Tail Assembly.
FIG. 616. — Plan of Stabilizer-Elevator Frame.
FIG. 617. — Plan of Fin-Rudder Frame.

**A Wing-band** is used instead of wing-clips to hold the wing to the fuselage. The band must be of fine rubber

like that used in golf balls, so that it will not pull too hard upon the frames. There are two ways to attach the band. One way is to pass it under the fuselage, slip its ends over the wing tips, and slide the loops over to the center. This method is shown in Fig. 603. The other way is to slip the loop ends into the notches of the

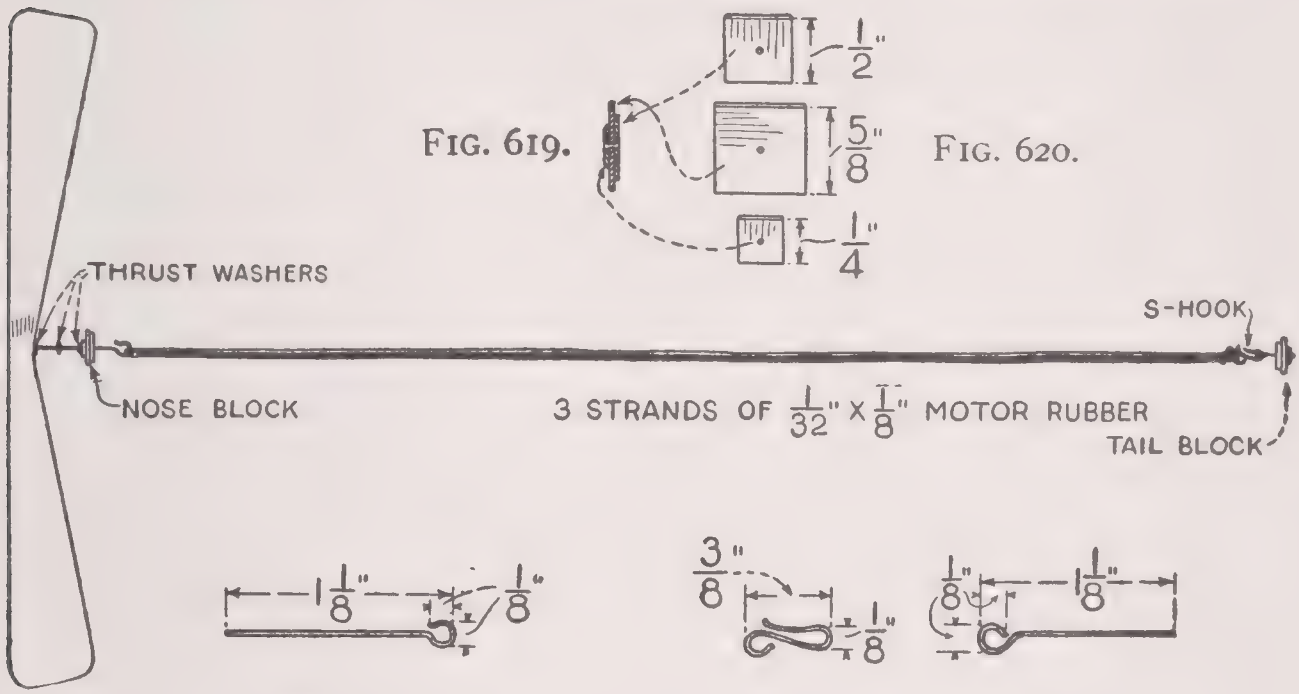



FIG. 618. FIG. 621. FIG. 623. FIG. 622.

FIG. 618. — Motor Assembly.
FIGS. 619 and 620. — Details of Nose and Tail Blocks.
FIGS. 621–623. — Details of Propeller Shaft, Rear Hook, and S-Hook.

incidence blocks. The latter method does away with the danger of breaking the wing frame.

**The Tail Assembly** is shown in Fig. 615. Build the frame for the *stabilizer-elevator* like the pattern in Fig. 616, and paper its lower surface. Build the frame of the *fin-rudder* like the pattern in Fig. 617, and paper one side of it.

Mount the fin upon the stabilizer with the front edge on the center spar, the rear edge $\frac{1}{4}$-inch to the left. This will make a $\frac{1}{4}$-inch offset, or warp. Join the tail to the fuselage with the outrigger spar shown in Figs. 603 and 615. Cut away the paper where it crosses the framework formers, and cement the spar to the formers.

**The Motor Assembly** is shown in Fig. 618. Instead of a motor base, there are nose and tail blocks to support the propeller shaft and motor hook. These are made to fit snugly in the fuselage ends. Figure 619 shows a cross-section of a block, and Fig. 620 gives the dimensions of the three pieces of balsa of which it is built. Center the pieces, one on another, as shown, and cement them together. Drill a hole in the nose block for the propeller shaft, and a hole in the tail block for the rear hook. Cement a thrust washer to the front of the nose block (Fig. 618).

**The Wire Fittings** consist of a *propeller shaft* (Fig. 621), a *rear hook* (Fig. 622), an *S-hook* (Fig. 623), and *wheel axles* (Fig. 632). Shape them of No. 8 music wire, with the aid of round-nosed pliers.

**The Propeller** is carved out of a block of the size shown in Fig. 624. Follow the steps shown in Figs. 625 to 628 in carving it. After squaring the block, draw diagonals through its corners, upon opposite faces, and push a pin through the centers to drill the shaft hole. One-sixteenth inch each side of the center, draw a line parallel to the side edges, to mark off a hub $\frac{1}{8}$ inch wide.

Then cut away the edges of the block along the diagonal lines (Fig. 625). Draw a diagonal line across the block ends, from corner to corner, in the directions shown, and the block will be ready to carve.

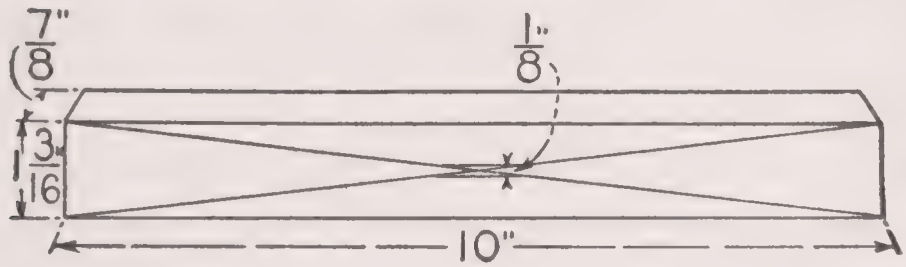



FIG. 624.

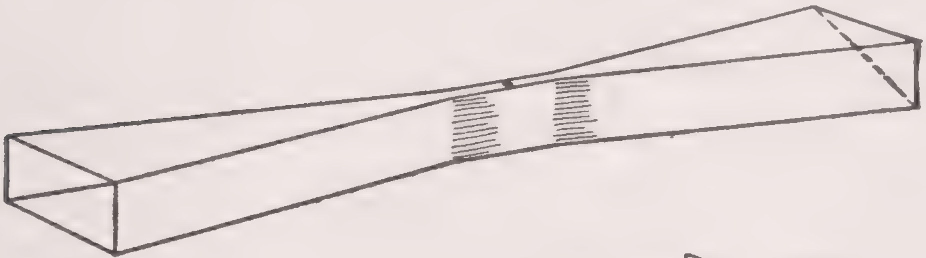


FIG. 625.

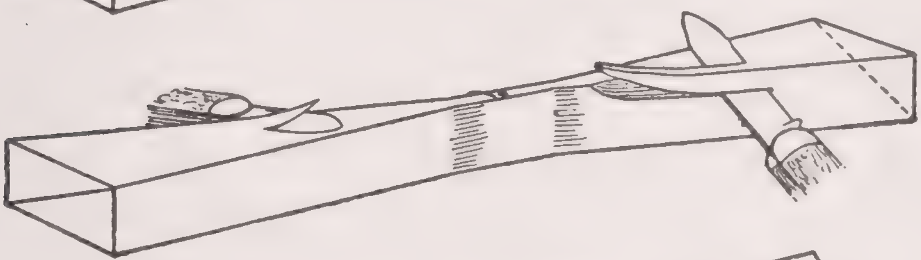


FIG. 626.

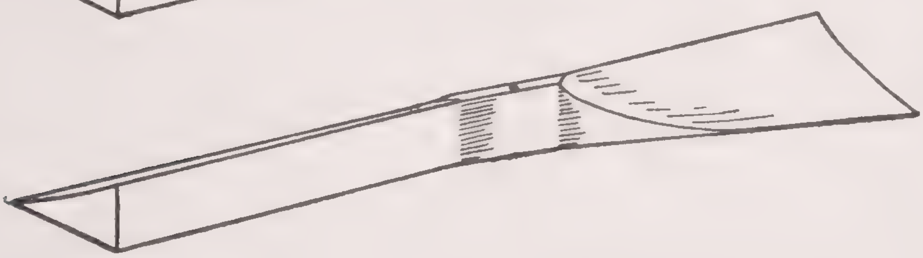


FIG. 627.

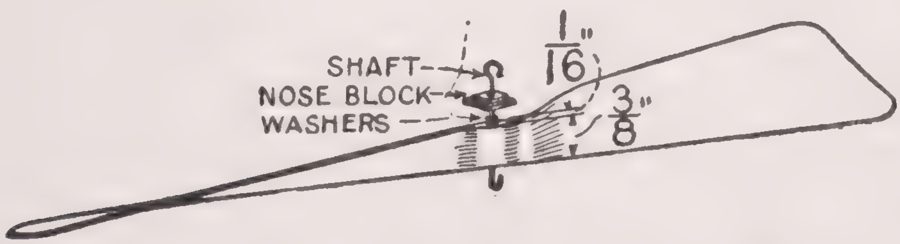



FIG. 628.

FIGS. 624–628. — Steps of Carving the Propeller.

**Carving.** Cut away the wood upon opposite edges, as shown in Fig. 626, a little at a time, to a point $\frac{1}{16}$ inch above the end diagonal lines. Even off the surfaces,

then smooth with fine sandpaper, and make them slightly spoon-shaped, or cambered (Fig. 627).

Invert the block, and carve the edges of this face in the same way. Smooth the surfaces, and sandpaper slightly convex-shaped. Then sandpaper the blades to a thickness of about $\frac{1}{32}$ inch. Reduce the width of the hub to $\frac{1}{16}$ inch, and reduce the thickness to $\frac{3}{8}$ inch, cutting away the hub on the inner face (Fig. 628).

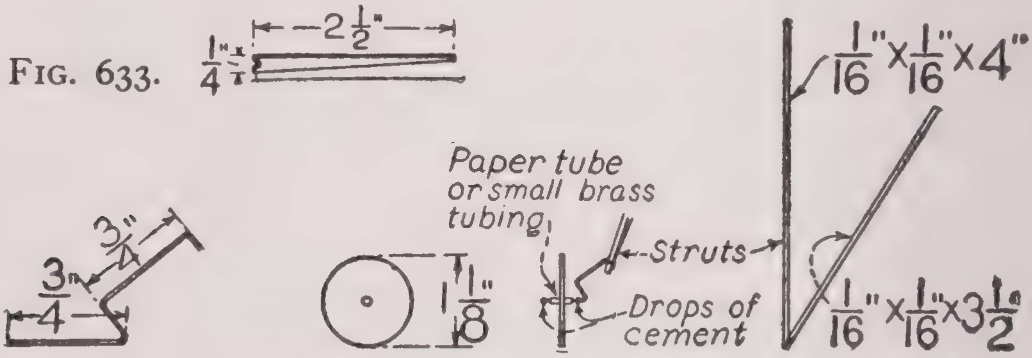



FIG. 633. FIG. 632 FIG. 630. FIG. 631. FIG. 629

FIG. 629. — Landing-Gear Struts.
FIG. 630 and 631. — Landing Wheel.
FIG. 632. — Axle and Shock Absorber.
FIG. 633. — Tail Skid.

**To Mount the Propeller,** slip the shaft through the nose block, three thrust washers, and the hub, bend over its end, coat this with cement, and draw it back into the hub. Cement one of the washers to the hub (Fig. 618).

**The Motor** requires 31 inches of rubber $\frac{1}{32}$ inch by $\frac{1}{8}$ inch. Knot the ends, place the knot at the S-hook, and slip the loop over the shaft hook. To install the motor, drop the S-hook and rubber through the nose and rear end of the fuselage, and slip it over the rear

hook. Then fit the nose and tail blocks into the ends of the fuselage.

**The Landing Gear** requires two pairs of struts like those shown in Fig. 629. Cement the upper ends to the fuselage longerons, and bring the lower ends together and cement them. Cut the *wheels* out of balsa, of the size shown in Fig. 630. Make *hubs* $\frac{1}{4}$ inch long of paper rolled into tiny tubes, or of small brass tubing, and cement them in holes drilled through the wheel centers, as shown in Fig. 631. Make *axles* of No. 8 music wire, with the upper ends shaped for *shock absorbers*, as shown in Fig. 632. Cement to the landing-gear struts, as shown in Fig. 631. Figure 633 shows the *tail skid*. Notch the wide end to fit over the next to the last former-frame. Cut away the tissue-paper covering of the fuselage at the point of attaching, so that the skid can be cemented to the former-strip.

**Finish the Ship's Cabins** with *windows* and *door*. Figure 635 shows a full-size pattern for the window for the left side of the ship, and Fig. 636 shows a pattern for the windows and door for the right side of the ship. Figure 637 shows patterns for the pilot-cabin windows. Make tracings of the patterns upon thin paper. It looks best to draw the outlines in ink, but if you find that ink causes the thin paper to wrinkle, use a soft pencil. Cut out the tracings and paste them on the fuselage papering. The positions for the windows are indicated upon the fuselage-frame pattern (Fig. 634).

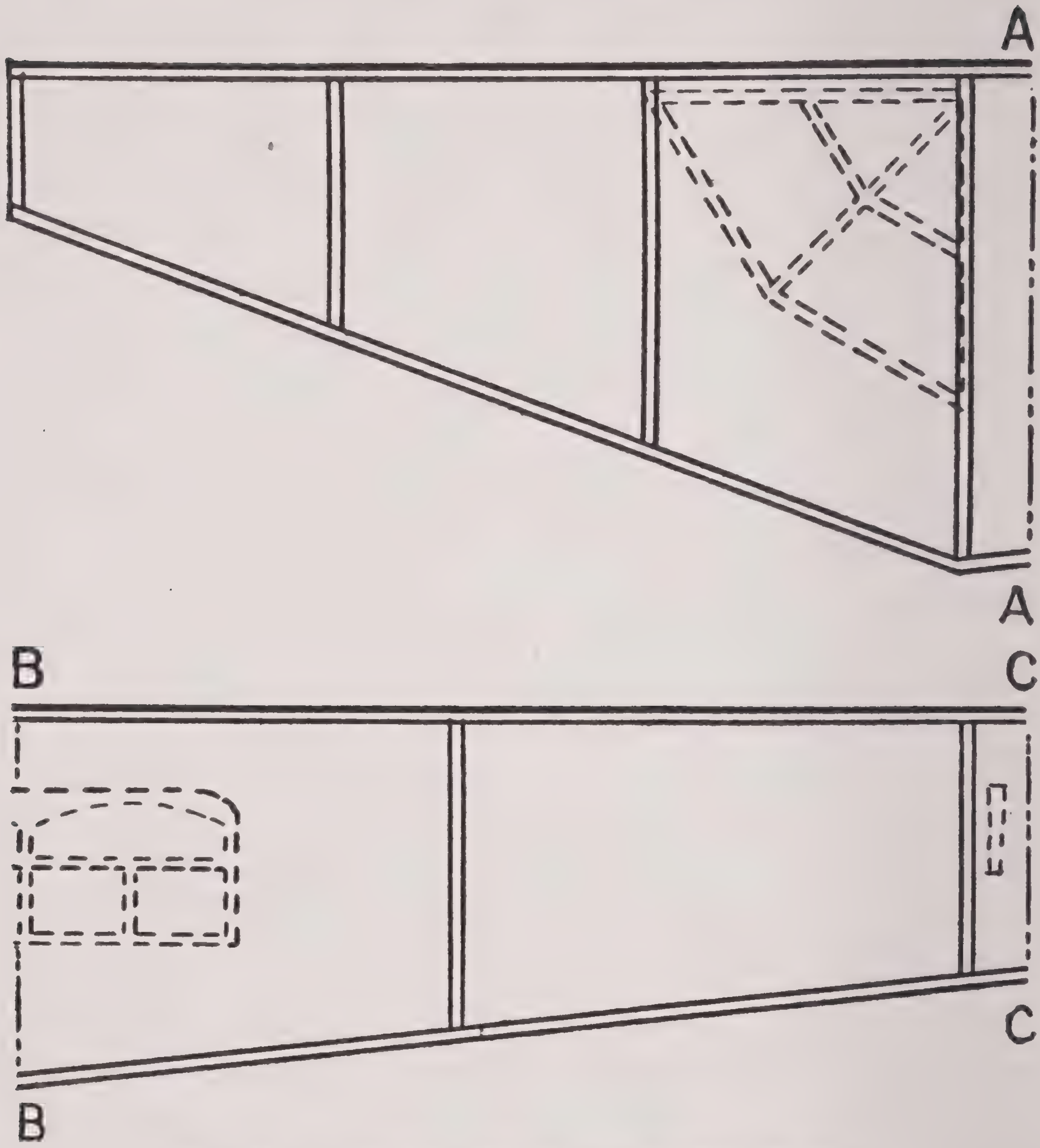
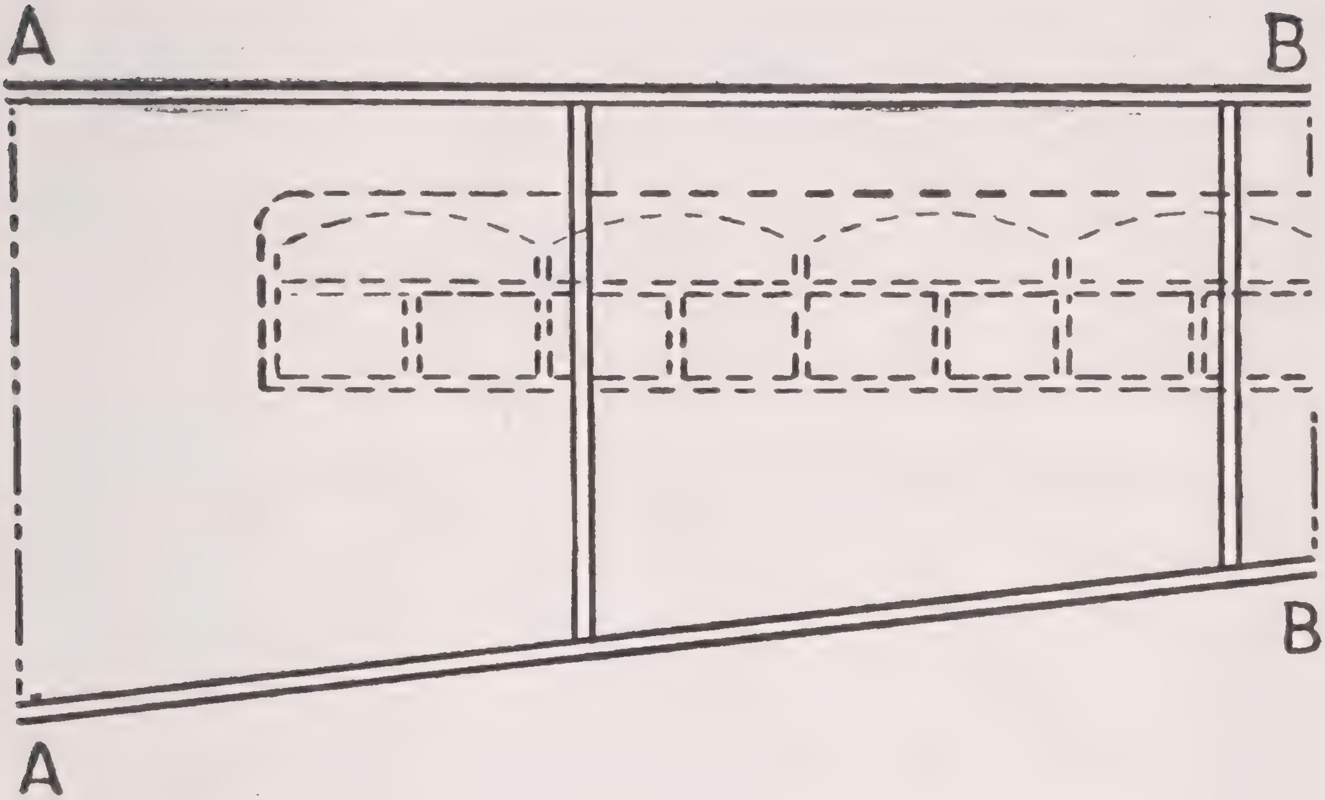
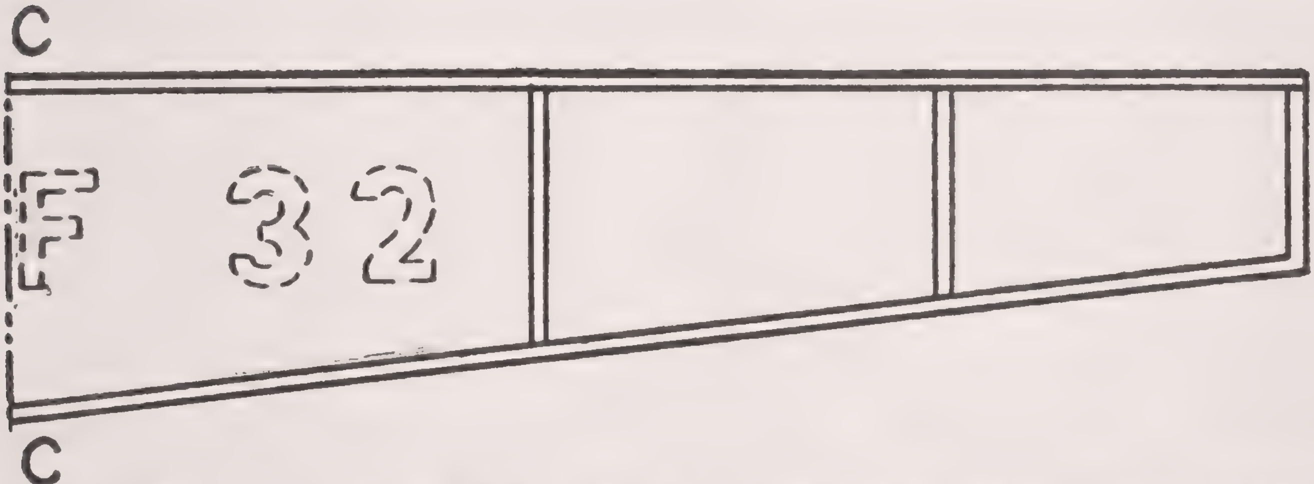



FIG. 634. — Full-size Patterns for Fuselage Templet.

FIG. 635. — Full-size Pattern of Cabin Windows (Left Side).




Make Tracings of Parts, joining Ends *A* of the First Part to Ends *A* of the Second Part, Ends *B* of the Second Part to Ends *B* of the Third Part, and Ends *C* of the Third Part to Ends *C* of the Fourth Part.

FIG. 636. — Full-size Pattern of Cabin Windows (Right Side).

Indicate *ailerons* on the wing, and the division of fin and rudder, and stabilizer and elevator, as shown in Fig. 603. And do not forget to add the ship's *insignia* "IF-32" upon each side of the fuselage, near the tail.

**Tuning the Model.** To tune the IF-32 for a flight, place the wing about where it is shown in Fig. 603, and

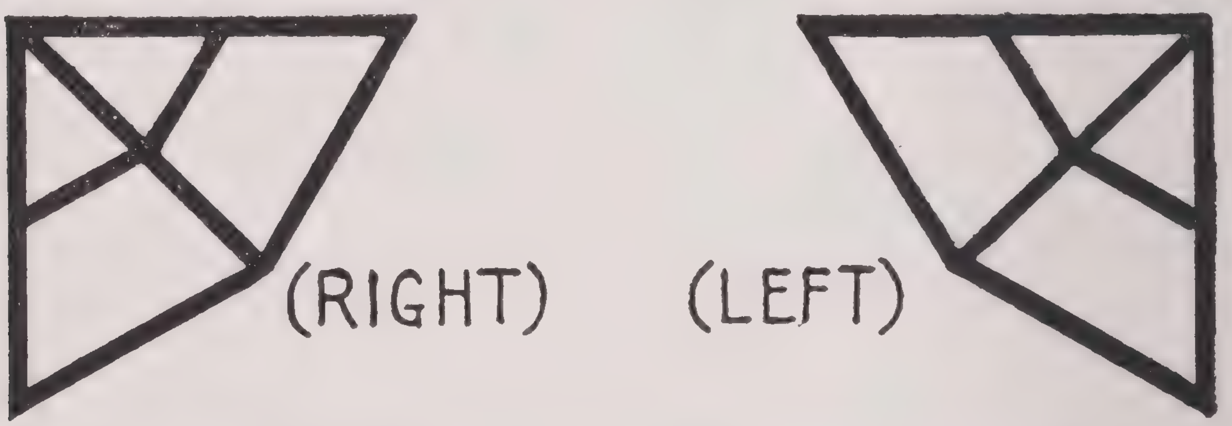



Fig. 637. — Full-size Patterns of Pilot Cabin Windows.

try out the ship as a glider. If it dives at a steep angle move the wing a trifle forward. If it climbs steeply, then stalls and slips back, move the wing back. In this way, you will quickly discover the point at which the ship glides on an even keel, and with careful piloting, you will enjoy a lot of successful flights before an untoward crack-up brings about

THE END.

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